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Military-Civilian Technology Shift for 1990-2000

90CF0241C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 25 Dec 89 p 3

[Article by Xiao Qinfu [5135 0530 4395]: "The Shortest Route to Two-Way Development of S&T and the Economy"]

[Text] **1. A Look Back**

The defense science and technology industry is a prominent height in China's science and technology, whose close-knit, systematic organizational forms bring together many high-quality science and technology resources and results and which has considerable research capabilities. The proportion of scientific and technical personnel among white- and blue-collar workers is fully 13 percent in the defense science and technology industry, compared with a national average of only about 3 percent in most departments of China's industry and transportation system. The defense science and technology industry has a full complement of sectors, with superior facilities. As a result, making use of the industry's advantages is a rapid route to achieving two-way development of science and technology and the economy.

Since the policies of reform and opening up began, and especially since 1983, efforts to shift military-industrial technology to civilian use have achieved noteworthy results. First, technology transfer, consulting services, and joint breakthrough efforts have resulted in the transfer of more than 40,000 technologies to the civilian departments and have overcome more than 3,000 long-standing technological problems for the civilian departments. Second, military plants have been converted to the production of civilian goods, and major use has been made of defense research capabilities, technical facilities, and technological results. The output value of civilian goods produced by the defense science and technology industry has increased from 10 percent of its total output value in 1979 to 66.6 percent in June 1989; these products involve the mining, metallurgy, machinery and electronics industries and include 40 major categories and more than 7,000 varieties. Furthermore, such measures as having military units develop production operations and opening military installations has resulted in the use of large amounts of technical facilities and technical personnel for national economic development. For example, more than 300 specialized military railroads, with a total length of more than 1,000 km, equivalent to the length of the main lines under an entire railway office, have been opened to civilian transport.

Experience indicates that the shift of military-industrial technologies to civilian use has an immense effect and a profound influence on the two-way development of science and technology and the economy in China. 1) It has expanded the scale of output of the national economy. 2) It has promoted the development of civilian-technology and high-technology industries. The shift of advanced technologies in such fields as aviation, space, nuclear power and electronics has solved many difficult problems in civilian technology and processes and raised the level of processing and manufacturing; in addition, the development and opening up of such sophisticated fields as positron-electron colliders, nuclear power plants and communications satellites has vigorously promoted the development of sophisticated industrial technologies in China. 3) It has increased market supplies. 4) It has strengthened capabilities in the key areas of development of the national economy. Military-industrial technology and military enterprises have been an invigorating factor in such key areas of economic development as the coastal development strategy, the opening up of China's West, replacement of imports, expansion of exports, and improvement of economic benefits. 5) It has increased the vigor of military-industrial enterprises. At present, 67 percent of the country's military enterprises have converted completely or primarily to the production of civilian goods, so that they have successfully implemented a "second founding" in a situation in which military funds are in short supply and idleness of facilities was a serious problem, and have taken new paths of development. 6) It has promoted the development of military science and technology. The military-to-civilian shift has brought large amounts of income to the defense science and technology industry (technology-transfer transactions alone have amounted to more than 2 billion yuan), has stabilized the manpower supply and trained personnel, has found new points of growth, and thus has created conditions favoring the development of military science and technology.

It is therefore clear that under China's current conditions, the military-to-civilian shift is an effective means of enhancing technical progress and promoting the development of the national economy, as well as a realistic method of establishing a beneficial feedback cycle between science and technology and the economy, between defense science and technology and civilian science and technology, and between the military economy and the civilian economy.

However, there are still many problems and difficulties in the military-to-civilian shift that must be conscientiously dealt with. 1) The system has not yet been fully put in order. Although the military science and technology industry has implemented reforms involving planned transfer of leadership, closings and mergers and the management system has undergone major changes, economic relationships capable of accommodating both the military and civilian sectors have not yet been put in order. In actual operation there is no unified plan and no organic coordination, and the systems of the military and civilian sectors are still separate and distinct. 2) The operating mechanism is still not in good order. Because the military goods procurement system, and the military research contracting system and bid solicitation system have not been in place for long, military goods pricing methods are still being worked out by trial and error; it is

not clear who is responsible for civilian goods production, and in many enterprises the military-to-civilian shift has not become an organic component of production operations. 3) There is a lack of overall planning. There is no clearly specified strategic guiding idea or long-term unified program, and the production orientation and technological requirements for the development of the defense science and technology industry, its place and role in the national economy, and its interconnections with civilian science and technology industries are all insufficiently clear. The military-to-civilian shift is receiving weak support in terms of macroscopic policy, and the supplying of such resources as funds, energy, and materials has not yet been incorporated into the state plan, leading to such problems as provisional reliance on market regulation, uncritical development, and declining benefits. 4) The level of development is low. About 40 percent of state science and technology industry enterprises, organizations and units have not found technologies and products that they can use to support civilian production, and they are still in the condition of "looking everywhere for rice to put in the pot." Fewer than 30 percent of the military-industry enterprises' accumulated technology holdings have been shifted, and more than 70 percent of their capabilities have been put off limits. Their ability to adapt to market changes is weak.

2. Prospects and Suggestions

In the 1990's, the military-to-civilian shift must proceed in accordance with the above circumstances.

On the one hand, the achievements listed above will serve as a new point of departure for efforts to promote development in the 1990's. In particular, the following factors should produce a greater effect. 1) Attaching due importance to the subject. The military-to-civilian shift is already being treated seriously by the state, the localities, the military-industrial departments, the civilian departments, and the science and technology world; the state has set up "three-front adjustment program" offices; most provinces and municipalities have set up specialized leadership organizations; management methods and systems of regulations at all levels and of all types are continually coming into being; and defense science and technology results are being steadily declassified. There is no doubt that further intensification of this work must be promoted in terms of organization, leadership, operational programs, and the lessening of constraints. 2) System reform. The military products procurement system, the military research contracting system, the military goods pricing methods and military enterprise management will be steadily improved and renewed during the 1990's. In addition, in the context of the reform of the economic management system, the defense science and technology industry's macroscopic management system will be further adjusted with reference to the specific deficiencies of the particular time, and its combined military-civilian character will become increasingly pronounced and stable. 3) Expansion of channels. Experience in the previous stage indicates that opening certain primary channels for the military-to-civilian shift such as the technology market and technology business, the modernization of military enterprises, lateral ties, establishment of manufacturing and trade bodies and research and production combines, conversion of plants to civilian production and the like will undergo new and sustained development during the 1990's; at the same time, there will be more pronounced progress in such areas as involvement in regional development, externally oriented development, and the development of high-technology industries. 4) Preparations for the organization of personnel, experimentation, and enterprises. Defense science and technology already has a large contingent of enterprise management personnel and scientific and technical development personnel who understand the market and are thoroughly versed in management, and continuing efforts will be made to train such personnel; it is apparent that they already understand and have mastered certain characteristics of the military-to-civilian shift and have solid experience, and that the enterprise production and management system will be increasingly able to adapt to the needs of the military-to-civilian shift and military-civilian ties. These factors will make themselves felt during the 1990's. 5) International competition. The development of the international situation has already given rise to an increasing tendency for the status of countries to be determined in terms of economic and technological competition. Under the guiding idea of maximizing the speed of scientific and technological development, the U.S. and Soviet approach of intensifying the promotion of civilian economic development by means of military science and technology will stimulate the military-to-civilian shift in China in the 1990's.

On the other hand, if the above problems are not solved with dispatch, they will become constraining factors that will hinder development in the 1990's. Judging by the present situation, the solution of these problems in the 1990's will vary in speed and ease: 1) The system will be improved via further reform and by continuous trial-and-error efforts, feedback and coordination between enterprises, departments, localities and the state; but in view of the difficulty of the overall economic system reform, it will be difficult to make the system more rational. 2) In the context of comprehensive enterprise reform and the maturing of a combined planned-economy and market-adjustment system, it will be difficult to put matters in good order quickly. 3) Overall planning is likely to become rather effective. 4) The level of development is likely to be raised considerably.

To summarize, in the 1990's, the military-to-civilian shift will give rise to a more vigorous and workable development situation and will promote the two-way development of science and technology and the economy to a more pronounced degree than in the 1980's. It is predicted that in the 1990's its development will have the following characteristics: 1) By systematizing past economic lessons and introducing new policy measures, development will become increasingly balanced and will

aim at real effectiveness. 2) Quantitative expansion will generally stop at the late 1980's level, but the economies of scale brought about by improved quality will become increasingly pronounced. 3) The structural move toward optimization, and activity in high-technology fields, will be further strengthened, and the exclusive production of civilian goods by enterprises will become important. 4) Production orientations will gradually become clear, and production centered on the aviation, space, nuclear power and electronics industries will be intensified. 5) Externally oriented development, including technology export and product export, will become more prominent. 6) Rather large-scale organizational innovation will take place both within enterprises and organizations and units and between them, with cooperation and integration progressing steadily. 7) State macroscopic regulation and support will be stepped up, and the influence of plan guidance will increase relative to that of market guidance.

To promote the realization of the above tendencies, in the 1990's it will be necessary to take the following policy steps in order to deal with existing problems and difficulties: 1) Accelerate the pace of system reform. Take the establishment of a combined military-civilian defense science and technology industry as the objective, start with the rationalization of relationships, make an effort to implement macro-scale military-civilian integration and micro-scale enterprise autonomy, and continue to promote new reform measures. 2) Intensify macroscopic plan regulation and control. The state should take an active intervention attitude, should foster a leadership state of mind, and should focus on effectively drafting a military-to-civilian shift policy, produce mid- and long-term programs, incorporate the military-to-civilian shift into a unified national economic development plan, implement various incentives and supports, and so on. 3) Improve information services. Industries, localities and other middle hierarchical levels should concentrate their efforts on effective information collection, processing and publication, with ties both behind the scenes and on the outside, using connections and building bridges. 4) Intensify personnel training. Enterprises, departments, localities and state organizations at all levels should use all possible methods to form a specialized personnel training system as early as possible so as to continuously develop a wide variety of specialized personnel with a good understanding of the market, and with skill in the cost-benefit analysis of civilian goods production. 5) Strengthen military research "reserve potential." Conscientiously investigate and deal with the conflict between transferring and keeping technologies, adjust the military spending structure, suitably increase military research spending and projects, and step up the establishment of military research contingents.

Eighth 5-Year Plan Basic Research Projects Chosen

90CF0241B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 23 Dec 89 p 1

[Article: "State Projects for Vigorous Developing During Eighth 5-Year Plan Designated"]

[Text] China has recently selected 12 major basic scientific research and basic applied research projects as driving projects for the Eighth 5-Year Plan.

The choice of the projects was based on China's summary program for long-term scientific and technological development and on the dispositions made at the national basic research conference held this February [1989]. The State Science and Technology Commission assigned the Chinese Academy of Sciences (CAS) the task of documenting this selection process. After more than a year of research and data collection and extensive consultation with experts, the CAS produced its research report, in which it selected major topics in basic scientific research and basic applied research. Recently the State Science and Technology Commission organized experts for a section-by-section evaluation of the report, and 12 final basic research topics were selected.

The topics that have already been evaluated by the experts are as follows: basic research on high-critical-temperature superconductivity; research on the structure and properties of optoelectronic materials, their molecular design and processes taking place during their production; research on climate dynamics and climate prediction theory; theory and methods of planning large-scale science and engineering programs; semiconductor superlattice physics, materials, and new device structures; utilization of superior male-sterile hybrid varieties of grains, cotton, and oil-bearing crops; prediction of future environmental trends in China and methods of dealing with them; nonlinear science; optimal nitrogen-fixation root-nodule control models; research and applications in present-day crustal movements and global dynamics; research in channel theory [traditional Chinese medicine]; and certain chemical aspects of life processes.

National Natural Science Foundation chairman Professor Tang Aoqing [0781 2407 1987] served as the chairman of the evaluation committee, which included a total of 65 experts. The evaluation process was divided into preliminary and overall evaluation stages and lasted a month.

Examination of the topics that were chosen indicates that the country has a good research base for most of them, qualified academic leaders, and the appropriate research contingent; thus, provided that the state furnishes the needed support, organization and management, it is expected that a group of research results at the world state-of-the-art will be obtained by the end of the century and that they will have an important effect on the raising of China's scientific and technological level, training of superior personnel, the development of the national economy, and improvement of the living environment.

The State Science and Technology Commission has decided that the implementation of the projects will be organized by the National Natural Science Foundation. During the process, they must further broaden their

solicitation of expert opinions and clearly define the scope of the topics, the subject matter of the research focus and the intended objectives; and they must divide each topic into several organically interconnected subtopics and make use of such techniques as publishing guidebooks, targeted submission of applications, expert evaluation, and competitive choice of projects for support, as well as designating the persons responsible for both the entire project and the component topics. In addition, the subject matter of the research must be coordinated and integrated with science and technology breakthrough projects, "863-Plan" products, and National Natural Science Foundation projects, and duplication and dispersal of efforts must be avoided.

CAS Director Summarizes Research Plans for 1990-2000

90CF0241A Beijing RENMIN RIBAO [PEOPLE'S DAILY] (Overseas Edition) in Chinese 16 Dec 89 p 1

[Article: "CAS Lays Out Research Plans for Next 10 Years"]

[Text] In the 1990's the Chinese Academy of Sciences (CAS) will strive to become an active scientific center with international influence in major leading-edge fields, to obtain advanced results that receive international recognition, and to make a contribution to the major, long-term, integrated scientific and technical problems of China's social and economic development and to the continuous provision of highly qualified personnel for applications development and for high-technology industries.

Speaking at a conference attended by the directors of more than 120 Chinese research institutes, CAS director Zhou Guangzhao today revealed that while continuing effective activities in its research institutes, the CAS will also make a conscientious effort to operate state open-access laboratories in key fields as well as large-scale state research bases, to intensify international cooperation and exchange, and to develop distinctive Chinese characteristics.

He stated that in the next 10 years, the CAS will make some high-level contributions that will win international recognition in such fields as high-temperature superconductivity, particle physics and synchrotron radiation, nuclear reactions and fusion, surface and interface science, solar and terrestrial physics, molecular and cell biology, global climatic change, and lithospheric evolution and the laws governing ore generation. In addition, the academy will vigorously promote certain major disciplines such as neuroscience, nonlinear science, cognitive science, and artificial intelligence, in order to move rapidly to the world forefront in these areas.

As regards resources and the environment, the academy will proceed with direct reference to the needs of China's social and economic development, make systematic, integrated investigations of resources, and carry on research in mid- and long-term forecasting of catastrophic climatic change and in satellite applications systems.

Zhou Guangzhao stated that for some time to come, agriculture will continue to exert particular pressure on China's stability and development. In addition to intensifying its work on integrated development and management of China's medium- and low-productivity regions and on improvement of crop varieties, the CAS will step up research on high-output agriculture under resource constraints and will make new contributions to developing agricultural science and increasing agricultural output.

Symposium on Formulating Software Protection Laws Held

90CF0176A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese, No 45, 22 Nov 89 pp 1, 12

[Unattributed article: "Formulate Protective Regulations To Shape and Industrial Environment"]

[Text] Computer software technology is one of the precepts for determining the development of electronic information technologies and the future information society, and it is also the key by which all nations of the world are striving for scientific and technological, economic, and military advantages. Software technology in China has gone through several years of trial, from which it has made much progress, but an independent software industry has yet to form. This formation requires a favorable environment, one aspect of which is the formulation of software protection laws. In 1986, the State Council determined that the Ministry of Machine-Building and Electronics Industry (MMEI) would be authorized to draft software protection regulations, and since that draft is now done, it is expected to go into effect in the near future.

On behalf of this effort, the editorial department of this paper invited pertinent leaders and some specialists and professionals from the worlds of computing, law, and publishing to participate in a symposium. There, the specialists and professors drew up the requirements and feasibility for computer software protection regulations, and also entered into discussions on related subjects. The experts spoke without inhibition, discussing several valuable opinions that are outlined below.

The necessity of formulating protective regulations

Peng Shulian [1756 2885 1670], Chief of the Office of Rules and Regulations at MMEI, led off with a speech, getting right to the point:

"If computer software technology is to develop, it is essential to arouse the enthusiasm of software development personnel, and if we are to do that, then we must protect their results and acknowledge their value. There

is no question about the necessity of formulating protective regulations." He want on to summarize, saying that the goals of this formulation are to protect the achievements of software development, to encourage the enthusiasm of developers, and to advance the cause of the software industry. He also made it clear that the formulation of protective regulations should first concentrate on protection, during which full consideration must be made for the situation in China.

The growth of software technology lags far behind that of developed countries, which is both all the more reason to encourage and promote it, and is also advantageous for the importation of such technology, which is the philosophy guiding this enterprise.

Shen Rengan [3088 0088 1626], Director of the State Bureau of Publishing, also spoke profoundly:

"The nation must prosper, and the key lies in our cultural and economic policies. The essence of good policy is in arousing enthusiasm. The key to that is the fact that it is people's intelligence that creates that enthusiasm. According to pertinent statistics, 90 percent of the value created by workers is a function of intellectual effort. Computer software is an outstanding example of just that intellectual creativity. That is why I consider the formulation of software protection regulations to be necessary on several accounts: first, by protecting legal rights we can do the most to arouse enthusiasm. On the one hand, software is an invisible property, and the development of software requires much learning, and large-scale software requires a large number of people for its development. In another sense, software is easily copied, and without much expense it can be copied for use, where the result is identical with the original. Illegally copied software is flooding the market and no one pays attention, nor are there any laws by which to manage this, all of which seriously harms the enthusiasm of development personnel. Second, software protection regulations are part of the social environment and conditions necessary to the creation and development of a software industry.

"The software industry is a knowledge- and labor-intensive intellect-based knowledge industry that includes software development, production, circulation, and service, and without a single regulation encouraging software production and circulation or protecting the rights of software enterprises, it is difficult to form an industry. During software development and production, the following situation applies: a new product comes out and it is evaluated as being "a lost cause." So, after the evaluation, how is it to be disseminated and applied, how is it to be modified, for there is no one to do it? These phenomena all arise from the lack of protection regulations, making it impossible to acknowledge the achievements of their labor. Third, when it comes to opening to the outside, there simply must be laws and guarantees, or foreigners will be unwilling to invest, since there are no laws and protections for the software achievements that have been developed. Many foreign firms have an interest in investing here, but they feel uncomfortable and are still vacillating. What is more, our own exports also have difficulties as, once again, there must be laws upon which to rely regarding the outflow of talent and the importation of intellectual resources."

Zhou Xiling [0719 6932 0109], Director of the Beijing Institute of Information Engineering went on to speak:

"Only with legal guarantees can there be hope for the establishment of a software industry, and many are waiting for just that. Without legal protection, it will be difficult to import much good software. When protective regulations appear, there could be additional costs involved at first, but the software industry would have such broad horizons that this would spur us on in our own research and development."

Chen Wenjian [7115 4489 0256], head of the Software Institute of the Chinese Academy of Sciences [CAS] said:

For many years, the software system in China has been a scientific research system, one that has been hard to turn into a production system. And in this kind of situation, many people have been willing to deal with methods and make discoveries who have been unwilling to undertake software engineering. The reason is that it takes a great deal of energy to do this, but the achievements do not have the protection of society, nor is the labor compensated.

Chen Weiyi [7115 4850 5030], Director of the Office of Policy, Rules, and Regulations of MMEI, said:

The nature of legal protection is that it is a stimulant and encouragement to the software industry, and it must not be seen as simply restrictions. I believe that the spirit and essence of regulations are that they will use the form of rules and regulations to stimulate our industry. That some people believe creating software protection protects the rights of foreign firms while harming our own, is shallow and short-sighted. Software protection is the same as the necessary legal protections of other industries in that they are a commodity of a product economy. If software is to become product, then there must be legal protection, and legal protection appears to be imperative.

There must first be copyright laws, then protective regulations

During the symposium, many leaders and specialists spoke to the observation that however software protection is undertaken, there would be a process of cognition.

Professor Zheng Chengsi [6774 2052 1835], high-level researcher at the Law Institute Under the Chinese Academy of Social Sciences and Director of the International Copyright Symposium spoke to that point:

There are two directions in world copyright law: one is in the United States, where they have placed software directly under copyright law, with a section dedicated to

the discussion of software, and where judicial interpretations, too, are derived from copyrights. The other approach is in Japan, Brazil, and South Korea, where they have established special legal clauses behind copyright law, and when interpretations are made, those interpretations exceed copyright law. Both approaches may be understood under industrial copyright, just differing in procedure.

Ying Ming [2019 2494], Assistant Senior Engineer at the China Software [Zhongruan] Company, said:

Brazil and South Korea have made a special clause under the major premise of copyright law. Actually, software is a text product, coming under the sphere of copyright protection. However, computer software differs from ordinary text products in two accounts: one, in that it is a tool, where the user need not understand its internal structure before using it, and it can even be modified and copied. Second, there is also the obvious characteristic of software that it is hard to discover any individuality, which stresses its generality. Therefore, in acknowledging that software is a knowledge product, under the premise that it enjoys copyright protection, it is necessary to draw up particular clauses, which has been the experience around the world, as well as the conclusion we have reached after much research. For these reasons we will provide the draft from deliberations as a special provision drawn up under the premise of copyright law.

Professor Chen Houyun [7115 0624 0061], the Computing Institute, CAS served as a member of the Regulations Drafting Group, and he talked in detail of the cognition process in how to select and use copyright law to protect software. "We have considered using patent law and trademark law to protect software, as has been proposed by several other countries, but after much study and discussions, we felt it was not appropriate to do so." He went on to remember that using copyright law to protect software was proposed by a lawyer with the U.S. IBM Company. The United States first used copyright law to protect software in 1980, then first resolved software disputes through judicature. It then became widespread throughout the world for principally two reasons: one, copyright law has material that is appropriate to protecting software, it is more convenient to so use it, and there are too many limitations with other kinds of law. For example, the provision "forbidding copying" in copyright is quite applicable to computer software, and nearly all countries have copyright laws, with copyright agreements even between countries. Two, there is the promotional role that the United States has played, the world nation most advanced in software is the U.S., and most system software is U.S.-made. Copyright protection has been beneficial to the U.S., so they have elevated software protection to a national policy, disseminating it vigorously, and it has permeated abroad to a great degree.

Professor Chen Yousong [7115 1635 2646], of Beijing Science and Engineering University, spoke further on the subject:

What is principally protected by copyright law is the manifestation of a product, but what is the form of computer software? What is its content? These things are hard to distinguish. It is for this reason that under the premise of copyright law it is imperative to draw up special regulations. Naturally, the appearance of software protection questions has been an attack upon law, and as other countries have not thoroughly resolved this problem, they have continued to vaccilate. Nor, of course, is it even possible for copyright law to resolve all questions in software protection, and we expect that the future will generate special law for the protection of high technology.

Is it too early to formulate software protection regulations?

There is currently one opinion holding that it is too early to draw up software protection regulations. Some say that the software developed by all units has been through government funding, and having been developed, it would be for use by everyone. Some say that China is still a poor country, we have not the money with which to import some advanced software, so if we can copy it, we should copy it. Why should we protect the advantages of foreign firms? There was much discussion of these questions at hte symposium.

Li Ye [2621 8763], Director of the Computer Department, MMEI, felt that the conditions for the "Software Rules and Regulations and Protective Regulations" to go into effect are now basically mature. First, the growth of the software industry has this as a requirement. I have often heard the following statement: "When protection laws go into effect, that will be the day the software industry is revitalized." We can see from the internal situation that the software industry in China having grown to this point, if there is to be a breakthrough, it will have to be stimulated by legal protections. Second, they are necessary to protect the rights of the developers. In previous years, we in China have held a few software marketing conferences that have been rather sparsely attended. We have good software, but developers are unwilling to make it available, for it is not easy to sell when they do, users being unwilling to spend the money to buy it. Nor is there any need to spend the money, since you can have it by copying. When we drew up the Eighth 5-Year Plan, we required that software preliminarily form into an industry during that period, that output value would reach 1 billion yuan, and that the software export goal would be US$50 million. This would be an indication that software production is in urgent need for the creation of a favorable environment. But software regulations have not yet gone into effect—what are we waiting for! Looked at from the outside, not adopting appropriate protection for software is unfavorable for international exchange and cooperation. The national policy of opening up to the outside world urges us to formulate protective regulations as quickly as possible. If we are to import advanced software, and if we are to put our own software out into the international marketplace, then this cannot be done without legal safeguards.

Finally, we have heard that not long from now, China's national copyright law will be passed after deliberation by pertinent organizations of the National People's Congress, and that promulgation of copyright law will create favorable legal conditions for putting software rules and regulations into effect. After a long period of fermentation and deliberation, there has been an improvement in the awareness of software protection. That is why I believe that the situation for the formulation of software protection rules and regulations is basically ready, and conditions are essentially prepared. There are, of course, still some unfavorable factors, first among which is that people's understanding needs further improvement, as we foster the imperative protective concept. Second, skilled personnel are hard to come by, those who both understand computers and also law are too few in number, and in this area, it may be said that we are insufficiently mature. Even so, we cannot wait for everything to be ready before considering software protection. That would be too late.

Chen Chong [7115 0394], Director, Software Office, Computer Department, MMEI, said:

The timing of software regulations going into effect and an understanding of the value of software are one and the same. Why should there be protection of software? Because it is so valuable that naturally we want to use whatever means to give it protection, means that must be appropriate to our national situation, and we must also consider the greater international environment. Our guiding thought is to provide protection, but that protection must be appropriate.

Many experts also spoke about whether conditions were right or not being the key to whether regulations can be put into effect. There are many factors in the question of whether conditions are right, including such things as the political needs of the state and a definite material base. Conditions are essentially right at present.

Advantages and disadvantages must be seen correctly

There are advantages and disadvantages in software protection going into effect, but the advantages are long-range, while the disadvantages are temporary, another subject that engaged symposium participants.

He Xingui [0149 2450 6311], Deputy Senior Engineer, Systems Institute, Commission of Science, Technology, and Industry for National Defense, said:

With protection regulations, there is no question but that we can arouse the enthusiasm of developers and stimulate the development of our own software. Even so, our software industry is still in a development stage, with a wide gap between it and those of developed nations. That is why we must still import good, advanced foreign software, but with protective regulations, the state could restrict imports. There would be temporary difficulties if that were the case.

Director Shen of the State Bureau of Publishing also said:

It is quite possible that after protection regulations go into effect, the usage fees we turn over to foreigners will be greater than the usage fees foreigners transfer to us. This conflict cannot be avoided, but looking at it from another point of view, we can regard those fees as tuition, as a pressure. This would force us to realize that we must do our own research, getting involved in development, and in this way the situation could evolve into a stimulus encouraging the development of our own intellects.

Jia Yaoliang [6328 5069 5328], General Manager of the Zhongruan Company, spoke:

International society is considering protection of intellectual property rights to be more and more important, and Japan has designated 1989 as the first year for intellectual property rights. If an industry does not have legal guidance, it is hard for it to prosper, a point on which several experts here have talked. That is why paying these costs will be only temporary, and they are necessary, as we conclude that advantage and disadvantage should be viewed over the long run.

Professor Chen Yousong, Beijing Science and Engineering University pointed out:

Software is an industry of potential in China, and if we have to temporarily put out money, in the long run this will be to our advantage. Additionally, protecting intellectual property rights and advancing development of intellect will aid the improvement of the cultural intellect of our entire populace, and this is an important expression and specific manifestation of respect for knowledge and respect for skilled personnel.

Professor Guo Shoukang [6753 1108 1660] of the People's University went a step further:

When software protection regulations go into effect, they will protect intellectual property rights and intellectual achievements, of that there is no longer debate. As to this question of advantage and disadvantage, what is to become legislation must be evaluated repeatedly. If there are difficulties that cannot be resolved easily, legal protection for computer software must also be reviewed constantly as it develops, so that it might be continually perfected.

The leadership and experts taking part in the symposium also commented upon the items of work currently before them.

One is to improve awareness, to intensify efforts with public opinion and publicity. The experts felt that only by improving awareness can we create a favorable environment, and at present, a deeper understanding is needed from management departments to enterprises, from leadership to researchers. Only by truly understanding the necessity and feasibility of implementing software protection can we more quickly and better spur

on the smooth promulgation and execution of software protection regulations. This is why the experts are calling for the relevant departments to intensify their public opinion and publicity efforts, recommending the organization of a series of lectures and initiation of systematic discussion activities.

Two, we must foster the talents of our people, and since too few people in the computer industry understand law, from now on we must arrange for and carry out this training in a planned manner, and must train a group of people as quickly as possible who both understand computers and also understand law. The computer industry is varied, as for example we do not even know how many types of CAD [Computer Aided Design] there are. It will therefore be very difficult to train that talent, and we should pay it a high degree of attention.

Three, we must establish a complete judicial system. After protection regulations have gone into effect, we must have a complete judicature to organize their practice. Whether regulations can serve their purpose depends upon whether they are themselves complete, as well as on whether they can be practiced successfully. Software protection regulations are the first industrial rules and regulations in the MMEI system, and they should be soundly and smoothly put into practice.

The three points just mentioned are also of concern to experts, who are worried that after promulgation of the protection regulations, these areas could become obstacles.

The symposium was held throughout the day, when many other valuable opinions were offered that cannot be detailed individually. The leaders, experts, and professors attending the symposium numbered more than 30, and they came from such organizations as MMEI, the State Publishing Bureau, the [China] Politics and Law University, [China] Peoples University CAS, and the Commission of Science, Technology, and Industry for National Defense.

Measure Indicators of Technology Transfer

90CF0017C Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 4, Jul 89 pp 15-18

[Article by Fang Xin [2455 2450] of the Chinese Academy of Sciences' S&T Policy and Management Institute: "On Measurement Indicators for Technology Transfer"]

[Text] Abstract:

This article provides detailed definitions and concepts of technology transfer, distinguishes it from normal commodities and commodity trade, and analyzes models of technology transfer. On this foundation, it integrates with actual conditions in China to suggest indicator systems for measuring international technology transfer.

Economic development and social progress in today's world depend on science and technology, but the development of S&T is uneven. Any nation, organization, and enterprise desiring success must be adept at absorbing the newest achievements of technological developments by others. Thus, technology transfer is an important part of S&T activities and national economic activities and it is the concern of governments in all nations. Technology transfers are global in scale and involve extremely complex mechanisms. Thus, ways to measure technology transfer, adopt the corresponding policies to promote technology transfer, and utilize indicators to reflect a nation's status in international technology development and competition and to reflect models and trends in technology transfer have become important research topics. This article centers on a discussion of several basic concepts, models, and measurement indicators for technology transfer.

I. Basic Concepts and Definitions

The first thing involved in establishing technology-transfer indicators is clarification of some basic concepts and definitions. "Technology transfer" has many definitions and is often used to describe many different types of activities, so a definition is essential.

Technology is the means or processes of man's utilization of scientific knowledge to transform or control his objective environment to meet human needs. It can be transferred in three forms: 1) technical products, which are technology in a tangible form like computers, etc. These products themselves are not technology but their cost, quality, or characteristics are substantially influenced by technologies materialized in them; 2) technical knowledge, which includes information, management techniques, etc.; 3) technical tricks of the trade and related technical data involved in the production process.

Technology transfer refers to the movement of a technology from a supplier to a recipient, which in essence is a form of exchange activity in which one party supplies the technology and the other party responds in various ways, usually monetarily. However, technology transfers are not the same as normal commodity exchanges. Their basic difference is that technology is not a common commodity. It has become a major factor among the primary factors in the forces of production in modern society and the value it can create far exceeds its exchange value. Its usage value, however, is latent. Its usage value is manifested only when the purchaser makes an additional investment and uses it in production. This creates a second difference. Normal commodity exchanges are considered to have been successful as soon as both parties complete the exchange, but a technology transfer does not stop at the exchange of a technology. It is only when the recipient truly understands and applies the technology that it is considered to be successful.

Technology transfers are not limited to transfers of tangible technologies in the form of trade. They also can involve the transfer of intangible technologies in many forms. Obviously, the "soft" aspect of technology transfers which involve the exchange of publications, circulation of ideas through personnel movements, and so on is very important, or are at least as important as the "hard" aspect of technology trade, and more often reinforcement of the "soft" aspect of technology transfer can produce many times the benefits with half the effort. The technologies being transferred can be high technologies or traditional technologies. The key is that the recipient selects appropriate technologies based on his own development goals and his actual manpower, material, and technical foundations.

Technology transfers can occur at different levels such as nations, enterprises, and so on. The increasing globalization of technical development and technical competition means that discussions of technology transfer usually refer to international technology transfer. China is a large developing nation and there is unevenness in the development of S&T between research institutes and institutions of higher education and industrial and agricultural production, between national defense systems and civilian systems, and between coastal cities and interior regions. Thus, the question of domestic technology transfer also deserves attention.

There are many different forms of technology transfer. The main ones are 1) direct imports of technical products and associated services; 2) assumption of responsibility for building plants, production lines, and so on; 3) direct foreign investment; 4) joint-venture investments; 5) permit trade and agreements on the transfer of technical tricks of the trade; 6) patents; 7) intergovernmental S&T cooperation plans; 8) international cooperation in research; 9) dissemination of S&T documents; 10) personnel exchanges, and so on.

In summary, technology transfers are extremely complex activities. To facilitate measurement, people prefer to use a narrow definition to limit them to a certain scope. I feel that when concretely analyzing this type of activity, one can begin with existing indicators and data, but to manifest the entire nature of this activity, it would be best to be somewhat more comprehensive when establishing indicators. For this reason, I lean toward the use of a broader definition.

II. Analysis of Technology-Transfer Models

To gain a better understanding of the process of technology generation, transfer, and utilization, I will propose a structural model for technology transfer based on the concepts of Rogers, Brown, and others. It is that technology transfer involves the supplying and recipient parties and intermediate links, all of which exist in a larger social and economic environment. These will be discussed in turn below.

If a technology transfer is to occur, the key lies in the common need to import a technology. It is precisely this need that creates a market for technology transfer, so the recipient is the active factor in a technology transfer. The success of a technology transfer is determined by the recipient's "absorptive capacity," meaning the capacity to select, understand, and apply a technology, including financial resources, basic facilities, personnel factors, and so on. If there is no absorptive capacity, a technology transfer is actually a technical movement and the technology cannot be truly assimilated. The process of importing a technology is actually a process of re-creation which includes the three stages of digesting, developing, and innovating. Innovation of an imported and then exported technology on the basis of importing is a successful development experience in many nations.

In essence, all technical knowledge which can be utilized must be transferred to actual applications. As the owner of a technology, the supplying side occupies a stronger position in the transfer process since it is the side which decides whether or not to transfer a technology, at what time and to whom, and what type of technology is to be transferred. The intellectual reserves and technical capacity it has are the fountainhead of continued development of its technology and the force behind the transfer process. The requirements of economic development, pressures of competition, and certain political factors can have a determining influence on its technology transfer.

The transfer of a technology from a supplier to a recipient is completed via intermediate links. These intermediate links include the many forms and mechanisms of technology transfer mentioned previously as well as various intermediary departments like international organizations, relevant government departments, banks, attorneys, research institutes and institutions of higher education, all types of consulting firms, small companies working with high technology which have appeared in the past few years, and so on. These intermediary departments play an important role in technology transfer and are closely related to the speed, direction, and scale of the transfer.

The supplier and recipient of a technology transfer have interrelated roles which are manifested in two areas. First, while the movement of a technology from a supplier to a recipient promotes the former's economic development, feedback information from the recipient to the supplier enables the latter to make suitable readjustments and changes for further development of the technology. Second, although there is relative stability among the supplying and recipient parties in an actual technology transfer, there are also frequent mutual changes in the supplier and recipient in consideration of the technology-transfer activities as a whole. Frequently, a nation or an enterprise is both a supplier and a recipient. Japan, for example, is a primary technology exporting country, but it is also an importing country which urgently imports new technologies from other countries. In another example, although China is a technology importing country, we also export technologies and technical products to other countries. The

reason for this phenomenon is that each nation has its own technical advantages, especially in the modern era with its rapidly developing S&T, and no country has a monopoly on technological development.

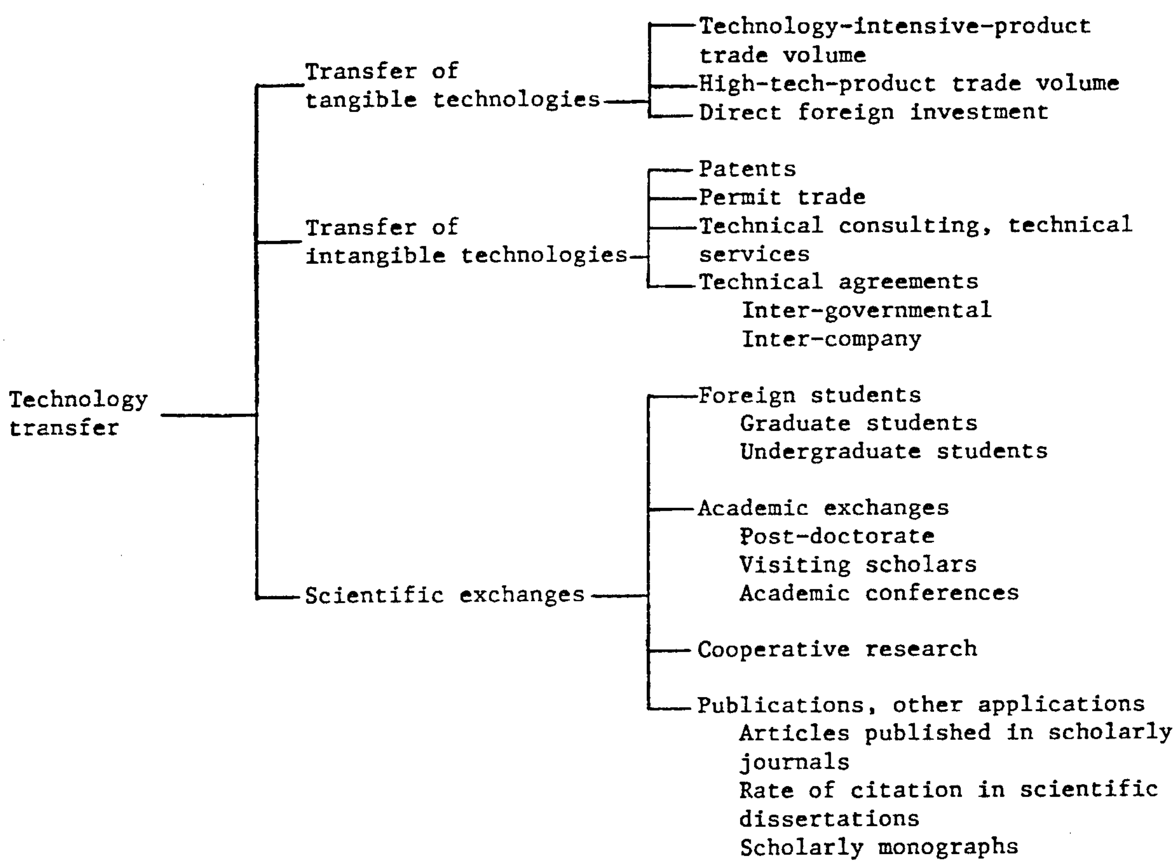
Lastly, there is an interrelationship between technology transfer and the environment in which it exists. Domestic technology transfer involves a domestic environment of policies from central authorities down to local areas, economic development requirements, and other factors. International technology transfer involves an international environment which includes East-West relationships, foreign-exchange conversion rates, trade balances, and many other factors. Whether one is speaking of the international or domestic environment, state policies, laws, and regulations are extremely important factors, as are social and economic structures. The degree of government intervention in development and resource markets (including manpower resources) and technologies also directly affects technology transfer. Of course, the larger environment also includes the content of an even deeper layer, which is the social and cultural background. It is quite obvious that the greater the difference between the social and cultural traditions of the supplier and recipient, the greater the difficulty involved in technology transfer. In another area, while technology transfer promotes economic and technological development, it also inevitably has a profound effect on the politics and culture of a society.

III. Measurement Indicators and Their Limitations

On the basis of the above discussion, the following indicators may be used to measure technology transfer. Because of the different qualities and characteristics of domestic technology transfer and international technology transfer and because of the current situation in statistical work in China, the discussion here will be concerned only with international technology transfer. All these indicators include both input and output aspects as well as distributions by region and country. Moreover, only single and dual-level indicators are listed here. Greater precision is needed during application.

Among these indicators, scientific exchanges reflect the "soft" aspect of technology transfer while the first two items reflect the "hard" aspect of technology transfer. Technology-intensive product trade involves the transfer of technologies contained in products between nations

Figure 1. Measurement Indicators for Technology Transfer



by means of product trade. It directly reflects the current situation of technology transfer, and via the international competitiveness of each nation's technology-intensive products it reflects the level of S&T in those nations. Because it is very difficult to stipulate technical measurements for a product, commodities in international trade are graded according to product grades or the related R&D in production industries. Products at the upper end of this yardstick are technology-intensive products classified according to international trade standards (S.I.T.C.). They include five items: chemical products, regular machine products, electromechanical products, transportation machinery products, and precision instrument products. Statistics on trade volumes include product trade as well as transfers of complete sets of equipment, production lines, and so on. Patents are another important indicator. Patent trends can illustrate developmental trends for inventions and innovations and they can describe changes in technology transfer and industrial organizational models. Patent statistics usually include the number of patent applications, number of approvals, and number of implementations or transfers divided by country and region. Patent utilization fees and permit fees composed of rights related to patents or international expenditure data in the area of services are other indicators for technology transfer. Statistically speaking, it is very hard to link expenditures with many different types of technologies, so in general one can only say that this nation is a technology importer or exporter relative to another country, which thereby reflects one side of that nation's S&T strengths and its status in international S&T development.

In summary, the indicators in the table can be used to reflect actual situations, transfer models, and circulation trends in technology transfer, but restrictions by many factors limit them considerably.

First, they have weaknesses common to social, economic, and scientific indicators, referring to statistical prerequisites that similar people have the same efficiency, that similar expenditures generate similar results, and that there be a direct relationship between output and input levels in the activities. Actual situations are not like this, however, so this type of indicator analysis only permits analysis of quantitative statistics and no qualitative analysis.

Second, these indicators have their own limitations: 1) There is insufficient information about certain important indicators. The high-technology-product trade volume provides a concentrated expression of the competitiveness of a nation's technology, but the varying definitions of high technology in different countries makes it hard to separate them from the trade volume for other products. 2) Because technology development and technology transfer have a global nature, multinational companies play an important role in international technology transfer. It is hard, however, for us to quantify and measure information and data about them. 3) While very good data may have been collected for each indicator, there are still problems involved in comparative analysis of them using a common measurement indicator. Personnel exchanges, for example, play an important role in technology transfer and the relevant statistical data are available, but it is still very hard to evaluate them accurately. 4) All these indicators are formulated beginning with the form and mechanisms of technology transfer and ignoring the role of intermediary departments. Beginning with research on the interrelatedness of the direction, scale, and speed between intermediary departments and technology transfer to formulate standards for measuring technology transfer is another topic that deserves intensive discussion.

Technology transfer can accelerate S&T progress, and it plays an important role in the social and economic development of a nation. Using a set of appropriate measurement indicators to control and evaluate these activities has become an urgent task. We should earnestly discuss the establishment of indicators, and we should use them to analyze the actual situation regarding China's technology transfer and continue to perfect them during use.

Technology and Software Fixed Assets

90CF0017B Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 4, Jul 89 pp 12-14, 24

[Article by Hu Xiuzhou [5170 0208 0719] of Jining Medical College and Hang Zhongmin [2635 0022 2404] of the Jining City Agriculture Bureau: "On Technology and Software Fixed Assets"]

[Text] Abstract:

Building a socialist modernized strong nation depends on science and technology. S&T are the most valuable special type of property and a primary force of production. For this reason, S&T should be treated as a special type of property in enterprise production management and administered as "software fixed assets." This article describes the meaning of technology as software fixed assets, the theoretical basis for their depreciation, and depreciation methods.

I.

Increasing labor productivity, accelerating the pace of the four modernizations drive, and quadrupling the value of output by the end of this century require reliance on S&T. Practice has proven that the role and contribution of S&T in development of the national economy grow as the forces of production develop. In Japan, S&T progress as a proportion of the factors behind GNP growth was about 20 percent from the late 1950's to 1960's, 38 percent in the 1960's and 1970's, and 65 percent from the late 1970's to early 1980's. Some have estimated that the role of S&T progress in the growth of China's national economy was 27.78 percent from the 1950's to 1975 and 31.47 percent from 1976 to 1980.[1] To quadruple the gross value of industrial and

agricultural output by the end of this century, the contribution of S&T to industry and agriculture must be 60 to 70 percent from 1980 to 2000.[2] It is apparent that S&T progress is the primary motive force and fountainhead to raise labor productivity and promote socioeconomic development. Science and technology are the most valuable special assets and primary forces of production. It is very important that special administration of these special assets be implemented.

After the first National Technical Achievement Fair in 1985, technology markets sprang up throughout China like bamboo shoots after a rain and they are quickly emerging and developing. Many patented and non-patented technologies have entered enterprises and are being widely applied in technical transformation, technical renewal, and new-product production and development. They have created significant economic benefits, accelerated the pace of industrial and agricultural modernization, and promoted product renewal and replacement as well as development of the socialist commodity economy.

II.

The application of S&T in enterprise production has greatly promoted enterprise growth. However, we must soberly note that if we fail to add guidance and reinforcement and do not eliminate all types of defects in management systems and certain irrational economic policies by formulating the corresponding management methods and guiding policies and by improving the environment and conditions for the reliance of economic construction on S&T progress, the initiative of enterprises to self-consciously utilize patented and non-patented technologies will be damaged.

The current enterprise financial management system includes investments in patented and non-patented technologies within product costs in the form of technical development expenditures. The purchase cost of a patented or non-patented technology is usually several 10,000 yuan or even several 100,000 yuan. This pattern of treating enormous investments in technology as circulating capital in order to apply the apportioned sales method to deal with apportioned sales within a short time period (a maximum of 2 years) obviously is extremely irrational. First, dealing with them in this way inevitably causes steep increases in product costs and substantial rises in commodity prices, which severely affects the interests of consumers. The result is often stagnant sales because the price of the commodity is too high, which makes it hard to avoid a passive and difficult situation. Second, enterprise benefits in the initial period of using a patented or non-patented technology are low, or the enterprises may even suffer losses, which artificially damages their initiative. Third, failure to implement specialized management of these technologies as special assets also makes it very hard to use the corresponding methods to establish special product-purchasing funds and it makes it impossible to apply them in a gradually accumulational and cyclical manner.

III.

Treating S&T as a special type of assets requires special treatment and specialized management. We feel that they can be dealt with by establishing the corresponding financial management system and accounting items. This means that these special assets are treated as fixed assets and handled using the limited-term depreciation method. These special fixed assets can be called "software fixed assets."

Software is symmetrical to hardware and so-called software fixed assets are the counterpart of hardware fixed assets. Fixed assets in the traditional sense refer to materials having a specific state, occupying a specific time, and having a specific weight and a rather high unit value (generally more than 300 yuan) which are used over a rather long period of time. All of them can be seen and felt, so they can serve as hardware fixed assets. On the other hand, technologies, techniques, methods, procedures, designs, programs, blueprints, tricks of the trade, and so on, regardless of their form of expression, as well as patented and non-patented technologies which are not primary applications are called software fixed assets.

A set of scientific financial management methods was put together quite early to establish financial management and accounting items for hardware fixed assets, and clearly categorized accounting items were set up. Software fixed assets, however, are a new thing and they are a blank page in present financial management. Things are rather chaotic and most are treated as a special situation in which transfer fees are handled like circulating capital and included together with expenses or paid out from contractual-responsibility surplus expenditures.

IV.

If patented and non-patented technologies are to be treated as software fixed assets, a set of scientific financial management measures must be established. There must be specific accounting items and they should be handled according to depreciation methods like hardware fixed assets. By using depreciation in this manner, a patented and non-patented technology purchasing fund can be established and included in normal economic operations.

What is the theoretical foundation for using the limited-term depreciation method to deal with software fixed assets in the same manner as hardware fixed assets?[3]

1. Software fixed assets used in production are the same as machinery, equipment, and so on, which constitute the material and technical foundation of enterprise production. They serve as a means of materialized labor in production and are an indispensable factor in the forces of production.

2. In the production process, they are used continually and repeatedly during a certain production cycle and do

not change their original shape. Their value is gradually and partially transferred to the new products along with continued utilization and wear of machinery and equipment or along with consumption of raw materials.

3. They are the same as machinery and equipment in value operations in that a part of them is gradually transferred into the new products and a part remains fixed in the original thing-in-itself. Thus, their value has a dual existence.

4. As S&T develop and the productivity of mental labor rises, amorphous losses also will occur during the turnover process.

It is apparent from this that there are common aspects between patented and non-patented technologies in essence relative to machinery and equipment. For this reason, there should be independent depreciation calculations for software fixed assets like those for hardware fixed assets.

V.

Usually, the utilization-time-limit depreciation method, course depreciation method, and so on are employed for hardware fixed assets. We feel that it would be most appropriate to adopt the accelerated depreciation method for software fixed assets. The reason is that there is an extremely close relationship between the value and time period of a technology which weakens as time passes, meaning that the annual amount of depreciation should be reduced in steps each year. Second, adoption of the accelerated depreciation method can speed up recovery of investments in technology and reduce investment risks and unanticipated losses.

The main accelerated depreciation methods are the yearly-limit total depreciation method and the diminishing-surplus depreciation method. Regardless of the accelerated depreciation method used, the first thing is to determine the utilization year limits for the fixed assets. There are usually conventions for hardware fixed assets, but determining the principle for software fixed assets is another matter. We feel that it is best to set the utilization year limit for software fixed assets equal to the time limit for patent rights protection, meaning that the depreciation time limit for patented inventions would be 15 years while the depreciation time limit for application of new types and exterior design patents would be 5 years, and it would be best to set 5 years as the depreciation time limit for non-patented technologies.

Regarding the residual value of fixed assets and settlement fees, there should be differences for software fixed assets and hardware fixed assets. We feel that residual value and settlement fees for software fixed assets do not have to be considered because there are no settlement fees and it is impossible or quite difficult to determine the residual value. When calculating the deduction for depreciation, the principle to grasp for software fixed assets is that when sufficient depreciation has been deducted, a technology which has not yet been discarded cannot be immediately discarded. Some can even be used for 10 years or over 100 years. The formula for Coca-Cola in the United States, for example, has been around for over 100 years. Its products are still being sold throughout the world without signs of decreasing and there is no shortage of people who would like to purchase this technology. In this situation, no additional depreciation is deducted regardless of how long the technology may continue to be in use. However, when sufficient depreciation has not been deducted for several technologies which were discarded early or abandoned ahead of schedule because they were inappropriate, an amount sufficient to compensate should be deducted.

How can the accelerated depreciation method be applied? An example can be used to provide a clearer understanding. An enterprise buys rights to use a new patent for a purchase cost of 20,000 yuan. How can depreciation be carried out? What they have purchased is the implementation of a new patent. Thus, the depreciation time limit is 5 years and the residual value is not calculated, so the total amount to be depreciated is 20,000 yuan. The year-limit total depreciation method is employed to calculate the deduction. The numerators for each of the yearly fractions are, respectively, 5, 4, 3, 2, and 1 and the denominators are 5+4+3+2+1=15, so the fractions for each year are, respectively, 5/15, 4/15, 3/15, 2/15, and 1/15. Each of the fractions are subtracted from the total sum of 20,000 yuan, so the annually diminishing yearly depreciation cost is 6,667 yuan, 5,333 yuan, 4,000 yuan, 2,667 yuan, and 1,333 yuan. This is shown in the following table:

Table 1. Deducting Depreciation Costs for Utilization of a New Patent

Year	Purchase Cost (yuan)	Useful Life (yrs.)	Fraction	Annual Depreciation (yuan)
First	20,000	5	5/15	6,667
Second	20,000	4	4/15	5,333
Third	20,000	3	3/15	4,000
Fourth	20,000	2	2/15	2,667
Fifth	20,000	1	1/15	1,333
Total				20,000

In summary, S&T are a special type of assets. The goals in implementing independent accounting and specialized management of software fixed assets are to establish a technology purchasing fund, increase accumulation of technology investments, ensure sources of capital for technology investments, and fully motivate the initiative of all enterprises to self-consciously utilize and develop patented and non-patented technologies.

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Re-Studying the Development of Biological High Technology

90CF0017A Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 4, Jul 89 pp 1-5

[Article by Zhang Shenbei [1728 3947 8951] of the Chinese Academy of Sciences' Shanghai Bioengineering Base: "Re-Understanding the Development of Biological High Technology"]

[Excerpts] Abstract:

After more than a decade of efforts by scientists and industrialists, several biological high-technology products have appeared on the market. The complexity of life phenomena and extremely strict demands placed on biological high-technology products, however, mean that this emerging industry will not produce significant economic benefits soon, despite everyone's hopes. We should understand their characteristics and integrate them with real conditions in China, look toward the future, reinforce investments, establish staffs, improve technologies, improve management and promote the development of biological high technology in China. [Passage omitted]

II. A Field with Considerable Potential

As a new field, biological high technology is not limited to existing economic benefits. Even more important is that it has great development potential. The United States magazine "Biotechnology" estimated that the total sales volume of bioengineering products in 1987 was US $660 million. This figure will increase to $2.85 billion in 1992 and $10.2 billion in 1997, a yearly growth rate of 30 percent. This is without doubt a very high rate.

The enormous potential of biological high technology is manifested in its wide range of applications. Biological high technology is now being applied or will be applied in the following realms: 1) pharmaceuticals: These include diagnostic reagents, drugs used to treat cancer, cardiovascular diseases, and viral diseases, vaccines, medical hormones, antibiotics, and so on; 2) agriculture: These include veterinary diagnostic reagents, veterinary medicines, drugs used to promote livestock growth and breed new animal and plant varieties, plant protection, and so on; 3) food-products industry and light industry: These include enzyme production and applications, enzyme reactors, amino-acid fermentation, organic acid fermentation, food-product and beverage fermentation, unicellular proteins, and so on; 4) environmental protection; 5) biometallurgy; 6) bioengineering equipment; This includes fermenters, instruments, automatic control, biological sensors, and so on; 7) military applications, such as detection of biological toxins and chemical toxins.

The influence of biological high technology can be expected to grow as scientific research intensifies. This latent strength has been recognized by the governments of many nations. In December 1987, Patrick Leahy, chairman of the United States Senate Agriculture Commission, gave a speech to the Senate on the topic "Future Competitive Abilities of Biotechnology in the United States." He pointed out at the beginning that "the United States is on the leading edge of a transformation, and this transformation will determine the fate of America's economic future. This is a scientific revolution brought about by biotechnology, ... biotechnology is now creating new and vast 21st Century markets, not only for American agricultural products but for many other industries as well. Biotechnology may provide solutions to many major problems in the world like hunger, disease, energy resources, pollution, and so on." The United States Senate also passed a bill to support development of biological high technology. [Passage omitted]

IV. Strengthen Investments, Look Toward the Future

Because of the rather high cost of biological high-technology research, many countries have now strengthened their investments not only to support developmental research in biotechnology but also to support the related applied research and basic research. The United States will allocate $50 million from 1989 to 1993 to establish a "National Biotechnology Information Center" in the Library of Congress to strengthen collection, preservation, analysis, and dissemination of biotechnology information. The European Community has decided to provide $150 million in funds for use in bioengineering in its 1987-1991 research budget.

Taiwan's Biotechnology Development Center was established and placed into operation in Taibei City in 1987. It now has a 10,000-square-meter research building and over 200 personnel, including 50 to 60 researchers who began working after studying for their doctorates in the United States. The Taiwan government provides this center with about $12 million in research funds each year.

Bioengineering companies in all nations of the world are concerned with strengthening their own R&D. For example, over 600 people are now working in the

research department of Genentech Corporation, including many research personnel who came form world-renowned Stanford University. This company spent $96.5 million on R&D in 1987. Many companies in the West have acknowledged that cooperation with university research departments and participation in long-term R&D cooperation is an important way to develop biological high technology. They have allocated enormous sums of money to support long term research in universities or research organs. The Monsanto Corporation, for example, signed a 12-year contract with Harvard University's School of Medicine to provide $23.5 million for cancer research. The Hoechst Corporation signed a 10-year contract with Massachusetts General Hospital which allocates $70 million for research in genetics. These future-oriented plans will play an enormous role in promoting development of biological high technology. Some new bioengineering companies established in the United States are extremely profitable. They have signed contracts with supporting companies and engage in biological high-technology research, with the patents they obtain belonging jointly to the supporters.

The development of biological high technology should combine long-term and short-term views, meaning that they should be concerned for present benefits as well as with the future. This conclusion has been drawn from involvement in the activities mentioned above.

V. Measures China Should Adopt

When deciding on suitable measures in China, we must take actual conditions in China into consideration. China is a large and poor country. We have to—quality scientific research and technical personnel, but our expenditures on scientific research are inadequate. We have rather good "upstream" research and technical forces but lack experience in "downstream" work. Our markets have a vast population but their purchasing power for high-technology products is inadequate. Given these realities, I feel that state administrative departments and scientific R&D units should be concerned with these issues:

A. Motivate initiative in all areas, and take full advantage of the role of existing scientific research organs (including research academies and institutes, institutions of higher education, and industrial departments).

China is a large nation and we should have a position in world scientific research. In competition on the two shores of the [Taiwan] Straits, we should have definite strengths. To develop China's economy in the 21st Century, we should reinforce our support of biological high technology.

China certainly does not have great financial strength now, and our money must be used in incisive ways. We certainly cannot afford to do things "indiscriminately." In light of the development situation over the past few years, it would be best not to build large and medium-sized bioengineering centers in the near term. I propose that all regions and units establish several small R&D organs according to their own financial situations. For previously established large and medium-sized organs, however, we should concentrate forces to complete or support their development. Over the past few years, price readjustments in the construction market and higher conversion rates for foreign exchange have led to excessive costs for some large and medium-scale projects. If we fail to increase budgets, the inevitable result will be construction schedule delays and an inability to complete the work; this will make us lose valuable time. State administrative departments should weigh the advantages and disadvantages, immediately adjust plans, and firmly decide to complete several centers to enable them to provide benefits as soon as possible.

B. Integrate long and short terms, combine high and low technologies, provide suitable financial support, and increase economic benefits in scientific research and development organs.

I mentioned previously that biological high technology is an industry with enormous potential strength, but this does not mean it can earn large amounts of money immediately. We must make inputs now to benefit in the future. China has already seen several [domestic] achievements in biological high-technology research, but careful analysis shows that certain products are still labor-intensive ones. We export unfinished manufactured goods which undergo precision processing into finished goods after they are sent to foreign countries, so most of the profits accrue to foreign commercial interests. There are also many products which lack strict inspections and clinical testing, and they cannot become drugs which meet specifications. For this reason, we must reinforce "midstream and downstream" research work in biological high technology, and this will take investments.

Returning to the question of intermediate-term testing, the task involved here is to gradually expand on laboratory achievements, explore large-scale production techniques, and select the most appropriate production conditions. There is a big difference between large-scale production conditions and laboratory work, but the former is no easier than laboratory research and it requires considerable manpower and financial resources, so it too should receive financial support. Evaluation of the economic benefits of intermediate testing involving biological high technology should not be done on the basis of the income it generates itself, but instead should consider its role in an industry as a whole. For biological high technology, simply requiring that intermediate testing bases "establish benign cycles" is not very realistic. However, from another perspective, scientific research and technical personnel working in China should also consider our real national conditions. To make scientific research stronger, compensate for operating expenses required each year, and improve the lives of S&T personnel, each organ should establish its own development department and use scale production to

transfer technologies to derive specific incomes. In view of the present situation, most products suitable for scale production are regular technologies. Because these technologies are more mature and markets have already been opened, they can derive definite economic incomes. This method of "using low technology to develop high technology" has been utilized in many biological high-technology companies and is still being used, and this is an experience which we can borrow.

C. Be concerned with market surveys, select good products.

Certain biological high-technology products which have already become forces of production and for which permits have been obtained internationally are not suitable for production in China. An example is the tissue plasminogen activator (TPA) product group produced by Genentech Corp. It is very effective in treatment of cardiovascular diseases (such as illness due to thrombus) but the drug costs $2,000 for each course of treatment, which is beyond the economic capacity of most sick people in China. We must carefully analyze the costs, selling prices, and markets for biological high-technology products and guide our industrial production.

D. Reinforce cooperation between China and foreign countries, strictly control imports.

Over the past few years, China has imported three recombinant hepatitis-B vaccine production lines, which is not an ideal situation. Each flow line (including software and hardware) costs several million dollars. It would seem to be more appropriate to use the money spent to import one line to develop the hepatitis-B vaccine we successfully developed ourselves. Regarding imports, state administrative departments should absorb the views of experts to avoid repeated waste or inappropriate use of funds.

To save import costs, we should strengthen international cooperation. By joining with major foreign corporations to develop and study new products, both sides would hold the patents, which would reduce import costs, and we could even obtain benefits. However, the basis for establishing this type of cooperation is our research strengths, and the state should expend considerable effort in this area to support construction of several R&D centers with definite international influence. In domestic R&D, we should advocate inter-unit and inter-departmental cooperation. Only in this way can we take advantage of our system. Too little is being done in this area now, and low-level repetition has wasted finances, materials, and manpower, so we should reform expenditure management to promote this type of integration.

E. Establish our own "FDA"

The issuance of production permits for biological high-technology products is a serious question with high technical requirements and a strong policy character. At present, the Ministry of Public Health is responsible for vaccine production, the State Medical Bureau is responsible for drugs, the Ministry of Agriculture is responsible for veterinary medicines, and the Ministry of Light Industry is responsible for production in the food-product industry. A division of administration among these departments often leads to protectionist measures which benefit a particular department and negatively affect development of biological high-technology products. I propose that the state establish a more detached administrative organ like the FDA (Food and Drug Administration) in the United States. This would substantially benefit development of biological high-technology industries in China.

I hope these views will receive the attention of the relevant leaders. Although these understandings are still very shallow in the long river of scientific development, each renewed understanding will move us one step closer to the truth and help guide our work.

Details of Chinese-Built F-7III Highlighted

90CF0277A Beijing HANGKONG ZHISHI [AEROSPACE KNOWLEDGE] in Chinese Oct 89 pp 18-19

[Text] Based on the experience in using the F-7 aircraft by China's Armed Forces, the Chengdu Aircraft Factory made a number of design improvements to the aircraft, and developed a series of new models: the F-7I, the F-7II, the F-7III, the F-7A, the F-7B, the F-7M, and the FT-7. Of particular importance are the following four models: the F-7II, the F-7M, the F-7III, and the FT-7.

The F-7II Aircraft

In order to fully explore the potential of the F-7 aircraft and to improve its tactical performance, the Chengdu Aircraft Factory began developing an improved model of the F-7 in 1975, the F-7II. The main improvements are in the following four areas:

1. The link-separation type ejection escape device has been replaced by the open, rocket-propelled ejection device in order to achieve zero-altitude, low-speed ejection for safe escape.

Ejection device is designed to provide safe escape by ejecting the pilot from the cockpit under emergency conditions. In the F-7 aircraft, the ejection seat is linked to the cockpit cover, and they are ejected as a single unit; after ejection, they are automatically separated. This design requires a complicated mechanism with many locking and releasing links, and often results in failure of the escape operation. The improved design uses open ejection where the cockpit cover is first discarded prior to seat ejection. In the new model II design, increased height is achieved by using a rocket-propelled ejection seat, and safe separation is ensured by using a man-seat separator. In case of an emergency, this device can provide safe escape at zero altitude and at an indicator speed of 250-850 km/hr. This ejection system was certified in 1979, and was used abroad for the first time in 1984. In this country, the ejection system had been used for safe escape five times by the Chinese Air Force prior to the end of 1985. In the same year, the model II rocket-propelled ejection seat received the national golden award for quality.

2. The brakechute compartment has been relocated upward to improve the landing performance of the aircraft and reduce the landing distance. With the improved design, the aircraft can open the brakechute approximately 1 m from the ground, and the landing distance can be reduced to within 800 m.

3. A 720-liter auxiliary fuel tank has been installed in the fuselage to increase the aircraft's range and endurance.

4. The new model is powered by turbojet-7B engines to provide higher thrust and improved flight performance.

On 30 December 1978, the improved F-7II aircraft was flight-tested for the first time by test pilot Yu Minwen. In September 1979, the overall design of the aircraft was certified. In 1980, it received the first-prize award for major technological innovation from the Office of Defense Industries of the State Council. The mass-produced F-7II has played an important role in modernizing China's Armed Forces; it has also been approved for export to other countries. On 1 October 1984, 35 F-7II aircraft in formations of 5 participated in the military review in Beijing, flying over Tiananmen Square.

The F-7M Aircraft

The F-7M aircraft is developed from the F-7B design; it is another new model of the F-7 series built by the Chengdu Aircraft Company. Since 1979, in an effort to accommodate the needs of foreign customers, the Chengdu Aircraft Co. (previously the Chengdu Aircraft Factory) has developed the F-7A, F-7B and F-7M models by importing advanced onboard equipment from abroad, and exported these aircraft to other countries. The most successful of the re-designed models was the F-7M.

The major design improvements of this aircraft included the following: incorporating 7 electronic fire-control units from abroad, redesigning the protective windshield against bird collision, installing a pair of external attachments, reinforcing the landing gear, and 8 other improved items. The aircraft is equipped with a number of advanced devices such as the horizontal display unit, the long-range radar with interference rejection capability, and advanced radio equipment; it also has high-accuracy rapid firing capability and air-to-ground attack capability. The design life of the aircraft, the engine and other parts have also been extended. The overall performance of the F-7M was significantly better than the F-7B; in the early 1980's, it became China's most advanced high-altitude, high-speed fighter aircraft.

The development work of the F-7M began in 1981 under the direction of senior engineer Tu Jida, who was appointed Chief Designer for the project.

In order to test the weapons system and the flight performance of the F-7M, many flight tests were conducted at the Flight Research Institute, and target tests were conducted abroad. Specifically, during 40 sorties and 18 hours of flight, air-to-air and air-to-ground weapons were launched from the F-7M, and "air combat" exercises with four other types of aircraft were performed. All test results were good.

In November 1984, the Ministry of Aviation Industry approved the technical certification of the F-7M aircraft. By 1985, all orders of the F-7M aircraft from foreign customers had been filled and the aircraft were delivered on schedule in accordance with the contractual agreement.

The successful development of the F-7M has demonstrated that it is feasible to improve the aircraft performance by importing advanced onboard equipment from abroad, and then export the improved aircraft to other countries.

The F-7III Aircraft

The F-7III aircraft is a high-altitude, high-speed, all-weather fighter aircraft; it is used for combat in daylight or darkness, and under difficult weather conditions. This aircraft has incorporated many changes in comparison with the F-7II. Specifically, 80 percent of the parts and 43 percent of the finished products were replaced, and 37 new materials and 190 new finished products were used. The major improvements were: installing an all-weather radar and advanced fire control system; enhancing the capability to carry missiles and rockets; using the new WP-13 engine; improving the ejection escape device; increasing the size of the fuel tank; and modifying part of the aircraft structure and external configuration.

The research and development task of the F-7III was formally assigned in 1981 to three organizations: the Chengdu Aircraft Design Institute, the Chengdu Aircraft Co., and the Guizhou Aircraft Co. Specifically, the design task was assigned to the Chengdu Aircraft Design Institute; the tasks of manufacturing and assembly of the fuselage and conducting flight tests were assigned to the Chengdu Aircraft Co.; and the manufacturing of the wing and the main landing gear was assigned to the Guizhou Aircraft Co. The entire development project was managed using a system engineering approach. The director for the project was deputy minister of the Ministry of Aviation Industry, Gao Zhenning, and the chief designer was Song Wencong. In April 1983, an on-site command post for the project was established, with Xie Mingren as the chief commander. During the development process, emphasis was placed on on-site command, service and operation, and a matrix management system was established to facilitate the development work.

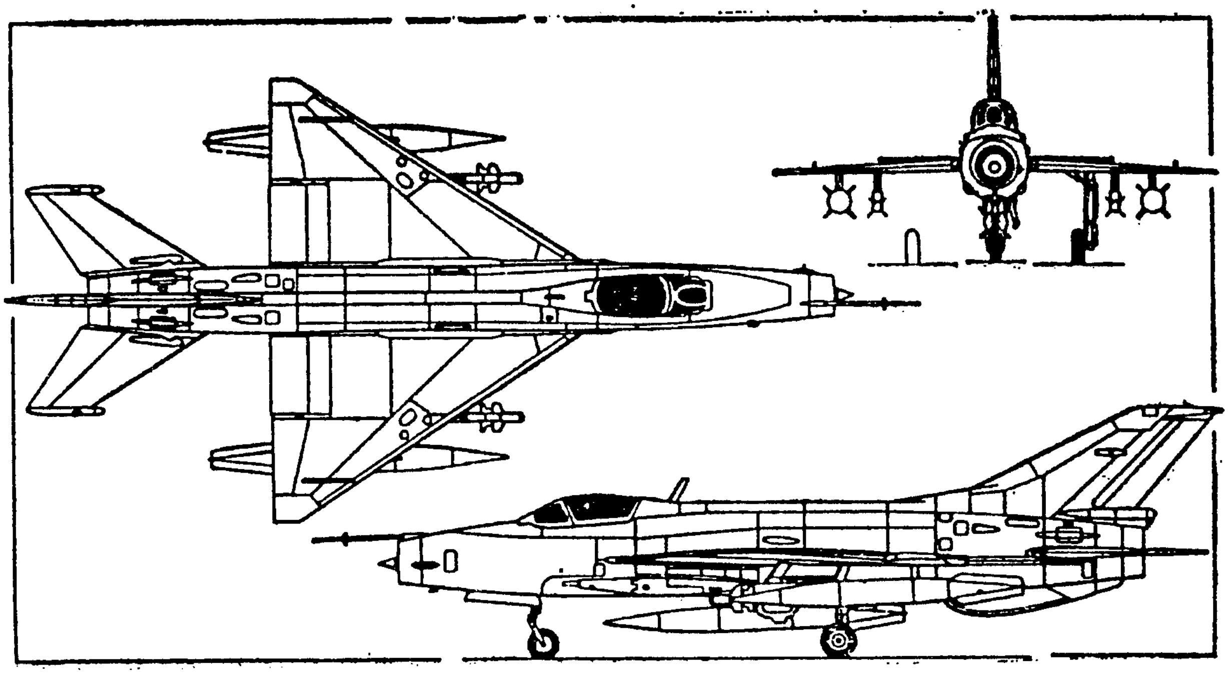
The preliminary design of the F-7III aircraft began in 1981; parts manufacturing began in 1982, and the assembly of the fuselage and the wing of the first F-7III was completed in December 1983.

During the assembly process, the Chengdu Aircraft Co. served as the headquarters which coordinated the various tasks of the supporting factories. The Chengdu Aircraft Design Institute assigned over 100 design personnel to monitor the production work; and all project managers and Party officials worked on site. Several hundred assembly workers and technicians worked diligently and efficiently to ensure a high-quality product. The assembly cycle of the first F-7III aircraft was only 30 days. On 6 February 1984, assembly of the first F-7III was completed and the aircraft was ready for test flight.

Unfortunately, during this critical period, an accident happened. On 23 March, an urgent message arrived from the Henan ejection escape test site: the rocket-powered ejection seat was tipped over during a ground test, destroying part of the fuselage and the rocket glide cart; as a result, the test had to be terminated. Since rocket ejection was a critical test that must be completed before the new aircraft could be flown, the on-site commanders immediately made a decision to build a new fuselage section and a new rocket glide cart by 1 April, and repeat the test. To meet this tight schedule, the Chengdu Aircraft Co. organized a team which worked around the clock for 9 days and completed building a new fuselage section; the Hubei Escape Equipment Research Institute also worked around the clock for 7 days and built a new glide cart. On 9 April the test was re-performed, and was completed in only 6 days, which was a record for this type of test.

On 6 April, the static test of a full-scale F-7III aircraft was successfully conducted. On 26 April, test pilot Yu Mingwen made his first flight in the F-7III. During the test flight, all systems functioned normally. By the end of December 1984, all scheduled tests and minor modifications of the aircraft were completed.

The successful development of the F-7III aircraft was attributed to the combined physical labor and technical knowhow of all the technicians, engineers, and Party officials working on the project. It represented a new stage of China's fighter aircraft development as system engineering procedures, matrix management systems, as well as new technologies, new processing techniques, new finished products, and new materials were extensively used in the development process. In particular, the cooperative effort between the Chengdu Aircraft Co. and the Guizhou Aircraft Co. in developing the F-7III was unprecedented in the aircraft industry.



Three Views of the F-7M Aircraft

Key: Key technical data: length 13.95 m (not including the pitot tube), wing span 7.15 m, height 4.10 m; dry weight 5,275 kg, normal take-off weight 7,531 kg; maximum engine thrust 4,400 kg; maximum Mach number 2.05, cruising speed 2,175 km/hr; static ceiling 18,700 m; maximum sea-level climb rate 180 m/sec, horizontal flight acceleration time (accelerating from M 0.9 to M 1.2 at an altitude of 5,000 m) 35 seconds; take-off distance 700-950 m, landing distance (using brake-chute) 600-900 m; maximum range 2,230 km.

Research and Development of Long March Family of Launch Vehicles

90CF0134B Beijing SHIJIE DAODAN YU HANGTIAN [MISSILES & SPACECRAFT] in Chinese Sep 89 No 137 pp 27-31

[Article by Di Naiyong [6732 0035 1661], Senior Engineer, Chinese Academy of Launch-Vehicle Technology (CALT)]

[Text]

Birth of the Long March Family of Launch Vehicles

In 1965, based on its achievements in missile technologies, China established the specifications for developing a satellite launch vehicle. This was the beginning of the Long March family of launch vehicles.

The first member of the Long March family was the Long March-1, which was a three-stage rocket; the first two stages used liquid-propellant rocket engines developed on the basis of existing missile technologies; the third-stage used a newly developed solid-propellant rocket engine.

The success of the Long March-1 not only paved the way for the development and production of other launch vehicles of the Long March family, but also stimulated the development of rocket-related industries and technologies, which primarily included the following areas:

New Materials The Long March-1 used many new materials such as high-strength aluminum-magnesium alloy, titanium alloy, fiber glass and high-strength steel; thus, it promoted research and development in both metallurgical and chemical industries.

New Processing Techniques Many new processing techniques were used in the development of the Long March-1, which included: explosion shaping, tungsten-electrode pulsed argon arc-welding, single-sided argon (helium) arc-welding, ultra-thin-plate argon arc-welding, vacuum electron-beam welding, ultrasonic spot welding, explosion welding, micro-beam plasma welding, plasma high-temperature spray-coating, plasma cutting, shear spinning, chemical milling, and grating processing, etc. These new techniques provided the foundation for advanced manufacturing processes used in developing the Long March family of launch vehicles.

Electronic Technology All electronic systems on the Long March-1 were transistorized and miniaturized; the development of many sophisticated and highly reliable electronic components, semiconductor devices, and electronic equipment provided great incentives for China's rather backward electronics industry.

Building a Foundation for Future Development

All of China's retrievable satellites were launched by the Long March-2 launch vehicle, which was developed based on the technologies of long-range missiles and the Long March-1 rocket. However, it incorporated the following new technologies:

Platform/Computer Guidance System The platform/computer guidance system was a new technology of the 1960's. However, because of the low standard in inertial instruments and computer technology, it was difficult for China to implement this technology. The successful development of the platform/computer guidance system on the Long March-2 stimulated the research and development of China's electronics industry, computer technology, precision machinery and materials industry; it also raised the standard of China's guidance technology to a new level.

Swivel Engines A key technical issue in launch vehicle development is how to provide the control force for the control system. The Long March-1 used gas vanes for its control force. The Long March-2 used swivel engines which were clearly superior but more difficult to develop. The implementation of swivel engines requires the development of swivel platforms and propellant supply lines that can withstand high thrust and strong vibrations; it also requires the development of high-power, high-precision and fast-response hydraulic servomechanisms. The successful development of these important technologies provided the basis for the actuating mechanisms of the control systems of future Long March vehicles.

Propellant Self Pressurization The propellant tank must maintain sufficient pressure to ensure a constant supply of propellants to the combustion chamber of the engine. On the Long March-2, the oxidizer tank is pressurized by evaporating the oxidizer in an evaporator, and the fuel tank is pressurized by reducing the fuel temperature with a cooling unit. This technique is preferred over the gas-bottle pressurization technique because of its reduced weight and the resulting improvement in rocket performance.

High-Strength Aluminum-Copper Alloy The propellant tanks constitute most of the structural weight of the launch vehicle; therefore, reducing the weight of the propellant tanks is an important way to enhance launch capability. By using aluminum-copper alloy in place of aluminum-magnesium alloy for its fuel tanks, the Long March-2 achieved a 30 percent reduction in weight. In the process of developing the aluminum-copper-alloy tanks, a new welding technique was developed for processing materials with low welding coefficient and poor weldability. Subsequently, aluminum-copper alloy was used on all later Long March vehicles.

High-Thrust Rocket Engines The thrust of the Long March-2 engine was 690 kN [kiloNewtons] compared to 255 kN for the Long March-1 engine. In the process of developing this high-thrust engine, Chinese engineers were able to solve a number of key technical problems: 1) Through careful design of the injector and the thrust head, and after 16 combustion tests, they solved the high-frequency unstable combustion problem. 2) By installing a throttling ring in the system circuit and judiciously arranging the nozzles of the injector, they eliminated the intermediate frequency vibration caused by the coupling effect between the hydraulic pressure pulses and the acoustic vibration of the thrust chamber. 3) Through 28 tests of the turbopump and numerous design improvements, they solved a series of problems such as explosion of the turbopump, failure of the sealing unit, fracture of the induction wheel, and excessive wear of the bearings etc.; specifically, they developed a coaxial vertical turbopump designed to provide reliable service under heavy load. The successful development of the high-thrust engine provided a good foundation for the propulsion systems of the Long March-3, the Long March-3A, and the Long March-2E launch vehicles.

Since the Long March-2 was first developed, several improved models have been developed such as the Long March-2A and the Long March-2C, which had higher launch capability, and improved reliability and flexibility. Currently, a piggyback module has been added to the Long March-2 to carry a 250-kg payload in addition to the primary payload; the piggyback payload can be injected into a different orbit from that of the primary payload.

The successful development of the Long March-2 laid a solid technical foundation for future development of the Long March family of launch vehicles. Since the Long March-2, China's launch capability has reached a new level of medium payload from the level of small payload. This was a critical step in the history of the Long March family of launch vehicles.

Based on the Long March-2 design, another launch vehicle, the Feng Bao-1 [FB-1] was also developed. This launch vehicle has delivered six satellites into orbit in four successful launches (three satellites were delivered in one Feng Bao-1 launch). Under the revised plan of launch-vehicle development, however, production of the Feng Bao-1 has been terminated.

Breakthrough in Geosynchronous-Orbit Launch Vehicles

To meet the demand of launching China's own geosynchronous communications satellite, efforts were initiated to develop the next-generation launch vehicle, the Long March-3. The Long March-3 was not announced until it had successfully launched a Chinese experimental communications satellite into a geosynchronous transfer orbit in 1984.

The Long March-3 was a three-stage liquid-propellant launch vehicle; it was developed from the Long March-2 design with the addition of a high-performance third stage which used liquid-hydrogen and liquid-oxygen propellants.

In the process of developing the Long March-3 third stage, a number of design problems were encountered:

Liquid-Hydrogen/Liquid-Oxygen Engine The liquid-hydrogen/liquid-oxygen engine of the third stage of the Long March-3 has a vacuum thrust of 44 kN and a specific impulse of 425 sec; it has second-start capability. The engine consists of four thrust chambers which are supplied by a single turbopump; each thrust chamber can swivel [plus or minus] 25° in the tangential direction to provide the control force for attitude control.

The hydrogen-oxygen engine was an advanced technology first developed in the 1960's. To apply this technology to the Long March-3, a number of technical problems had to be solved: the problem of bearing strength at high and low temperatures; the problem of designing seals for liquid hydrogen; the turbopump resonance problem and the "flame condensation" problem.

Low-Temperature Material Processing Techniques The boiling point of liquid hydrogen is 253°C below zero; at such a low temperature, the mechanical properties and physical characteristics of many metallic materials undergo significant changes. Therefore, the selection of materials, design procedures and manufacturing processes for the engine and the liquid-hydrogen and liquid-oxygen fuel tanks became a challenging problem in low-temperature technology. Through a large number of tests, several thousand parameters of the mechanical properties and physical characteristics of both metallic and non-metallic materials in liquid oxygen (-183°C), liquid nitrogen (-196°C) and liquid hydrogen were determined. Based on these test results, heat-treated aluminum-copper alloy was chosen as the material for the fuel tanks. The outer walls of the fuel tanks were insulated by spray-coating with a layer of composite polyurethane foam-plastic material. The breakthrough in low-temperature material technology ensured the success of the structural design of the third stage.

The Longitudinal Coupled Vibration Problem When the fundamental frequency of a large rocket structure is near or equal to that of the propellant-supply system (which includes the supply lines and pumps), they form a closed circuit in which resonance may occur. This longitudinal coupled vibration often causes failure of the rocket structure and therefore must be suppressed in the rocket design. In the case of the Long March-3, the rather long rocket body produces a longitudinal vibration frequency close to that of the propellant supply system; thus the likelihood of longitudinal coupled vibration is quite high. In the design of the Long March-3, the resonance is effectively suppressed by installing a pressure reservoir in the supply system to isolate the system frequency from the fundamental frequency of the rocket structure. The solution of the longitudinal coupled vibration problem was a major breakthrough in understanding the dynamic characteristics of large rocket structures and liquid supply lines.

The successful development of the Long March-3 extended the launch capability of the Long March family of launch vehicles from low-earth orbit to geosynchronous orbit. It also demonstrated that China's Long March launch vehicles were technologically among the most advanced in the world.

The Long March-4 launch vehicle was designed to launch a payload into a sun-synchronous orbit or a geosynchronous-transfer orbit. It is a three-stage liquid-propellant launch vehicle, where conventional propellants are used in all three stages. The first and second stages of the Long March-4 are similar to those of the Long March-3; both are developed from the Long March-2 design. The third stage of the Long March-4 uses two newly-developed bi-directional-swivel [i.e. gimbaled] engines with a thrust of 50 kN [each].

In 1988, the Long March-4 successfully launched China's [first] weather satellite, the Fengyun-1, into a sun-synchronous orbit. The development of the Long March-4 added a sun-synchronous-orbit launch capability to the Long March family, and augmented China's overall launch capability to cover all earth orbits.

New Development Trend

Development of China's Long March family of launch vehicles will continue in order to meet the needs of the rapidly growing aerospace industry here and abroad. In addition to the existing launch vehicles which include the Long March-1, the Long March-2, the Long March-3, the Long March-4 and the Feng Bao-1, four new launch vehicles—including the Long March-1D, the Long March-2E and the Long March-3A—are under development.

The Long March-1D launch vehicle is developed from the Long March-1 design with improved reliability and flexibility, and enhanced launch capability. It is primarily used to launch payloads into low-altitude and medium-altitude orbits; during its ascending inertial flight, it can be either three-axis-stabilized or spin-stabilized, depending on payload requirements. For a 500-km-altitude, 57°-inclination orbit, its launch capability is 450 kg (three-axis-stabilized) or 650 kg (spin-stabilized). The first launch of the Long March-1D is expected to take place in 1991.

The Long March-2E is developed from the highly reliable Long March-2 design. Specifically, the core of the Long March-2E consists of a lengthened body of the Long March-2 rocket. Strapped to the core are four symmetrically placed liquid-propellant boosters 2.25-m in diameter and 15-m long. Each booster has an engine similar to the core engine, with a thrust of 744 kN, but it cannot swivel. When the booster accomplishes its task, it is immediately separated from the main body.

The propulsion system of the core engine of the Long March-2E is similar to that of the Long March-2 except for the slightly higher thrust. The first stage consists of four engines that can swivel in the tangential direction.

The second stage consists of five engines; one is a fixed main engine with a vacuum thrust of 736 kN, and the other four engines are tangentially swiveling floating engines with a total thrust of 47 kN.

The Long March-2E can be used in conjunction with many upper stages on the international market (e.g., PAM-D3, PAM-D4, AMS, SCOTS, STV) to provide a geosynchronous-transfer-orbit (GTO) launch vehicle; the GTO launch capability is 3 tons. The first launch of the Long March-2E is expected to take place in 1990.

The Long March-3A is a geosynchronous-orbit launch vehicle developed from the Long March-3 design; its launch capability is increased to 2.5 tons by improving the third stage of the Long March-3.

The major improvements of the Long March-3A are: an increase in third-stage diameter from 2.25 m to 3.0 m and extension of its length so that the propellant capacity is increased from 8.2 tons to 17.6 tons. The thrust of the third-stage engine is increased from 49 kN to 157 kN, and the two engines can swivel in both directions; the control system uses a four-axis platform to provide added flexibility.

A more powerful launch vehicle can be developed by combining the third stages of the Long March-2E and the Long March-3A; such a launch vehicle can launch a 4-ton payload into a geosynchronous transfer orbit. It is expected that the first flight test of this vehicle will take place in 1993.

Launch vehicles are the foundation for developing space technology. China will continue to improve the launch capability and the flexibility of the Long March family of launch vehicles and join the world space community to explore new territories in aerospace technology.

Figure 1. The Long March-2 Launch Vehicle [photograph not reproduced]

Figure 2. The Long March-3 Launch Vehicle [photograph not reproduced]

Figure 3. The Long March-4 Launch Vehicle [photograph not reproduced]

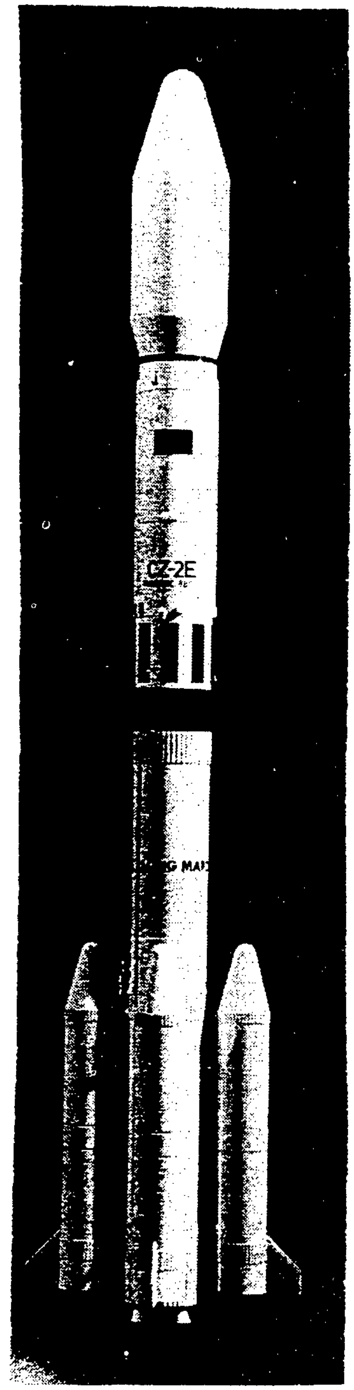


Figure 4. The Long March-2E Launch Vehicle

Table of Key Parameters of Long March Family of Launch Vehicles

Model	Lift-off mass (tons)	Lift-off thrust (kN)	Length (m)	Max. diam. (m)	No. of stages	Booster stage	Propellant First stage	Second stage	Third stage	Orbit	Launch capability (kg)
CZ-1 (LM-1)	81.5	1020	29.46	2.25	3	—	UDMH, HNO_3-27S	UDMH, HNO_3-27S	thiokol	LEO	300
CZ-2 (LM-2)	191	2770	32.57	3.35	2	—	UDMH, N_2O_4	UDMH, N_2O_4	—	LEO	2500
CZ-3 (LM-3)	202	2900	43.25	3.35	3	—	UDMH, N_2O_4	UDMH, N_2O_4	liq.H_2, liq.O_2	GTO	1400
CZ-4 (LM-4)	249	2900	41.895	3.35	3	—	UDMH, N_2O_4	UDMH, N_2O_4	UDMH, N_2O_4	SSO	1400 (900km)
CZ-1D (LM-1D)	81	1100	28.22	2.25	3	—	UDMH, HNO_3-27S	UDMH, N_2O_4	solid	LEO	700
CZ-2E (LM-2E)	464	5900	49.686	3.35	2.5	UDMH, N_2O_4	UDMH, N_2O_4	UDMH, N_2O_4	—	LEO	8800
CZ-3A (LM-3A)	240	2900	53.288	3.35	3	—	UDMH, N_2O_4	UDMH, N_2O_4	liq.H_2, liq.O_2	GTO	2500

Prospects for Chinese Applications Satellites Reviewed

90CF0134A Beijing SHIJIE DAODAN YU HANGTIAN [MISSILES & SPACECRAFT] in Chinese Sep 89 No 137 pp 15-19

[Article by Min Guiyong [7036 2710 2837], President, Chinese Academy of Space Technology (CAST)]

[Excerpts] [Passage omitted]

If the 1970's was a period of exploration and experimentation for Chinese satellite technology, then the 1980's is a period of developing and utilizing applications satellites. Three basic types of applications satellites have served more than a dozen organizations in the areas of space research, remote sensing, and general scientific research.

From the results produced by applications satellites, more people are becoming increasingly aware of the important role they play in economic development and in national defense. As a consequence, higher demands are placed on the design requirements of applications satellites. However, China is a developing country with very limited economic resources; its small investment in space technology cannot meet all the requirements proposed for the new satellites. We can only select those which are urgently needed and which will clearly produce social and economic benefits.

The critical issues which are currently facing the state and Chinese society include education and culture, transportation and communications, the environment and natural disasters, resources and population, and certain defense construction projects; we should regard these as China's high-priority issues.

1. Education is one of the major problems of our society today. Currently, there are a large number of illiterates in China, and opportunities for higher education and continuing education are very limited. These problems cannot be solved by increasing the number of schools and teaching staff due to the lack of funds and the long lead time required for school construction. An effective approach is to provide satellite TV education programs at various levels for the entire population. This will play an important role in improving the educational level of the general population and in raising the cultural and material standards.

2. The current state of transportation and communications is severely hampering the nation's development. The overcrowded transportation system in China is a well known fact. It not only hampers economic development but also causes social problems such as illegal sale of train tickets, etc. The use of satellite systems would provide an effective way to rebuild the transportation system and to enhance China's current transportation capability. The satellite's navigation, positioning and communications capabilities can be used to facilitate real-time coordination of various transportation systems, to improve the efficiency and speed of train operations. [Passage omitted]

Another issue which is directly related to the transportation problem is post and telecommunications. Current communications capability cannot satisfy the needs of the growing economy. [Passage omitted] Therefore, the development of satellite systems can solve the strategic problems in transportation, posts and telecommunications, and data communications, and thus contribute to the nation's economic development and defense construction.

3. The environment and natural disasters are also major problems for the nation. Fires, floods, hurricanes, tidal

waves, hail storms and earthquakes are encountered every year; they cause huge losses to people's properties and lives, and to the nation's economy. The big fire at the Anlin forest near Daxing in 1986 was a good example. With the aid of a satellite disaster-monitoring system, the location, growth trend and magnitude of the disaster can be determined on a timely basis; this information can be quickly reported to the relief organizations to plan for appropriate actions, and to mobilize rescue teams to the disaster areas via satellite-based communications networks. In addition, the command center can maintain direct contact with the disaster region to minimize the losses.

The rapid industrial growth in recent years brought severe pollution to the atmosphere and the water resources. In order to manage and control environmental pollution, it is necessary to constantly monitor the pollution conditions over the entire nation; this task can be very effectively carried out by satellite monitoring systems.

4. A difficult problem facing a developing society is to develop sufficient resources to support its population. This is a particularly serious problem for a country like China with a vast population.

China has rather limited resources over its landmass and its oceans; the amount of resources per capita is extremely small. In order to conduct resource surveys, to provide assistance to the mining and fishing industries, to develop new water resources, and to facilitate forestry and agricultural operations, an earth-resources satellite system should be established.

In addition, satellite systems are also needed to solve certain critical problems in national defense and economic development. Therefore, in the next decade, space technology should be devoted to providing services in the above areas. Specifically, we should first develop the following types of satellite systems:

1. Satellite Communications and Broadcasting System

The important features of this system should include: large capacity, high power, multiple beams and long design life. Its frequency spectrum should include not only C-band but also Ku-band and L-band in order to meet the needs of television education, stationary and mobile communications, special data and voice transmissions and TV broadcasting.

2. Satellite Navigation and Positioning System

The satellite navigation and positioning systems which exist today or are currently [under] development include the Meridian, the NAVSTAR and the geostationary GSTAR. The NAVSTAR system is too expensive and the Meridian system is already obsolete. The only feasible system for this country would be a GSTAR system which contains two to three satellites; such a system can significantly enhance China's transportation capability.

3. Environment and Earth-Resources Satellite System

This system includes both earth-resources satellites and weather satellites. Initial efforts should be concentrated on the development of land-resources satellites. The next step would be to improve the resolution, extend the frequency range, increase design life, and develop marine-resources satellites.

In the area of weather satellites, we should try to improve the performance of existing polar-orbit satellites; we should also develop geostationary weather satellites, increase the observation band, and develop techniques for monitoring atmospheric and oceanic pollution.

4. Disaster Monitoring and Rescue Satellites

Such a satellite system must have the capabilities of high-sensitivity remote sensing, and communications and position-fixing; it must also be able to provide timely response to its users. To establish such a system requires many satellites, including sun-synchronous satellites and geostationary satellites. The system can also be used in conjunction with other satellite systems.

In addition to the above systems, China should also develop certain applications satellites for its national defense.

In order to facilitate the development of applications satellite systems, we should emphasize preliminary research, design generalization and standardization, and concentrate on raising the standards of satellite technology, shortening development cycles and reducing development costs. In order to improve the quality of services provided by applications satellites, we should concentrate our efforts to enhance payload performance, develop common modules, and improve product life and reliability.

It is expected that in the next decade China will increase its investment in developing applications satellites, and the number of types of applications satellites will grow compared to the 1980's. As satellite performance is improved and design life extended, the total number of satellites probably will not increase significantly, but the ability to transmit information will increase by two orders of magnitude. In order to convert development costs into economic and social benefits as quickly as possible, significant efforts will be devoted to the study of satellite applications, and corresponding ground facilities will be constructed.

With the rapid development of the aerospace industry, the existing technical facilities will not be able to satisfy the needs of the 1990's. New aerospace facilities must be constructed to accommodate the needs of developing and launching different types of applications satellites; these include sophisticated environment-simulation laboratories, processing and manufacturing plants and satellite information ground receiving and processing facilities. This is a very urgent task.

While self-reliance is still our main policy in developing aerospace technology, it is expected that in the 1990's, China will increase its cooperative efforts in space exploration with other countries. Any applications satellite system can serve many different countries around the globe. Therefore, a joint effort in space exploration and in developing applications satellites which are of common interest should benefit all participating countries. China's primary goal in outer space exploration is strictly for peaceful purposes; the Chinese Government is willing to cooperate with any friendly country and to contribute its material and human resources for the advancement of mankind.

Developments in Software, AI Systems Reported

New Series of Math Software

90CF0130A Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 39, 11 Oct 89 p 14

[Article by Ji Shi [0679 1102]: "8000 Series of Mathematics and Engineering Software Reaps Excellent Economic Results"]

[Text] After completion of the mathematics and engineering software portion of the research project called "The 8000 Series General-Purpose Software Development (I)" undertaken by the Shanghai Institute of Computing, that project was included among those for dissemination and application during the Seventh 5-Year Plan.

Subjects contained within this set of general-purpose software include: the TSB application package for general-purpose algorithm software and the PDEPACK package for writing differential equations; the POP optimization package; the SAP7 non-linear systems static and dynamic analysis routines needed for engineering applications and non-linear structural analysis programs; and some applications software from the Shanghai Institute of Computing for solid-state mechanics, elastic mechanics, and their own for structural analysis. In accordance with the requirements for the six individual items just mentioned, they gathered together during the development process applicaiton software that had been imported and developed by pertinent units within China, as well as some accomplishments from development by the Shanghai Institute of Computing itself. They systematically made up this set from general-purpose software in each area, after analysis, debugging and actual computing.

All six parts were debugged and installed on an IBM 370/148; because the 8000 series is compatible with the IBM, all programs can be installed on the 8000 series of computers for use. They are broadly applicable, and may be used in such sectors and fields as scientific research, engineering, space navigation, economics, and planning. While running for more than a year, they have been responsible for excellent economic results, saving more than 3 million yuan in engineering funding for calculations of the Lubuge project stone embankment core filler materials.

Sinicized 'Symphony' Integrated Software

90CF0130B Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 39, 11 Oct 89 p 14

[Article by Wang Zhengsan [3769 2973 0005]: "Welcomed by Users—Symphony, Chinese-Western-Language Integrated Software"]

[Text] This integrated software being promoted with the technical assistance of the Shanghai Institute of Computing has such features as multiple functions, practicality, and convenience. This software integrates five software components: electronic spreadsheets, text processing, data-base management, graphics handling, and data communications. This integrated software uses window handling techniques to make usage much more convenient, and it has powerful communications capability, being able to effect data communications between microcomputers without additional hardware, which allows users to conveniently set up data communications networks.

The primary functions of this Chinese-and-Western-language integrated software are:

1. Electronic spreadsheets. This can help the user calculate and analyze accounts, can do financial analysis and decision-making, and can access, modify data, and display and print forms according to formats with which the user is accustomed.

2. Text processing. Text processing provides various file-handling functions for users.

3. Data-base management. This can arrange data input by the user in a defined sequence, allowing the entire data base to constitute a uniform structure, and at the same time it can handle several different data-record units, permitting the user easy and effective use of a data base.

4. Graphics handling. Graphics handling allows a user to generate various types of graphics and displays according to data stored in working tables, and with printout of these graphics, the user can take advantage of these graphics in whatever way is required.

5. Communications. Symphony has an independent communications window for data communications, one which can directly connect with the outside via communications links.

There are two versions of this integrated software—Chinese language and Western language. The Chinese-language version comes on eight disks, only six for the Western-language version, and with its additional materials on disk, this software is quite functional and has been welcomed by users.

Chinese Character-Recognition Advances

90CF0130C Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 40, 18 Oct 89 p 1

[Article by Du Haiping [2629 3189 5493]: "China's Chinese-Character Recognition Research and Applications Efforts Lead the World"]

[Text] The 3d All-China Chinese Character and Chinese-Speech Recognition Scholastic Exchange Conference recently came to an end in Lushan, Jiangxi Province, where more than 60 specialists from different sectors

throughout China discussed with one another new achievements made in China this year from research and applications in these areas. Forth-seven papers were read at this conference, 31 dealing with Chinese character recognition, and 14 with Chinese speech recognition and synthesis. We can see the following points emerge from these papers:

1. Recognition of printed Chinese character fonts has begun to be practical in China. Over the past few years, a group of practical systems has been promoted domestically, among which, the performance of systems offered by units at such institutions as the Beijing Institute of Information Engineering, the Zhengzhou PLA School of Electronic Technology, and Qinghua University are the most advanced. These systems usually recognize one typeface, but some can handle two or more; the number of characters recognized is generally the GB1 and GB2 [National Standard Levels 1 & 2] sets of Chinese characters; and the recognition speed ranges from a few to 20 per second.

2. There were clearly more papers on [recognition of] hand-written printed typefaces than at the previous conference, and the quality has improved, all of which indicates possible new breakthroughs in this area.

3. Research efforts on Chinese character recognition systems have become quite penetrating, and appears describing each link in the system (as for example, layout analysis, the pre-processing of such things as line-character separation, feature extraction, classification, match determination, sampling, and post-processing) constituted nearly one-half the number of papers at the conference. Many papers also brought out the importance of introducing phrase matching of text before and after in Chinese character recognition systems. A phrase [multiple characters in a string] is the basic processing unit in Chinese character information processing systems, and not only can they play important roles in recognition post-processing, but they also improve the system recognition accuracy and speed when applied to recognition classification.

4. Research on speech recognition and synthesis is beginning to flourish. Not only were there more papers on this subject than at the last meeting, but the quality was distinctly higher. The Language Institute of the [Chinese] Academy of Social Sciences has done surveys and analyses of many charts of disyllabic words, from which they have derived rules for coordinated sound changes of couplings between syllables, and that they have used to synthesize multi-syllabic phrases that are quite clear and natural; and the Radio Department of Qinghua University has urged speech recognition mechanisms to develop a speech printer, on which much progress has been made.

The experts believe that Chinese character recognition research and application efforts in China lead the world in that field. Our applications are of a considerable scale, and the system at the Beijing Institute of Information Engineering is currently being used by dozens of units. It is said that not long from now, the Great Wall Computer Group will contract to disseminate and apply this system on the Great Wall microcomputers.

New AI Language Compiler System

90CF0130D Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 40, 18 Oct 89 p 1

[Article by Xuan Gang [1357 0474]: "China Successfully Develops a New Artificial Intelligence Compiler System"]

[Text] A brand new artificial intelligence (AI) language compiler system (LPL) has recently been developed at the Beijing Institute of Information Engineering, and on 5 October in Beijing it passed its technical evaluation, sponsored by the Ministry of Machine-Building and Electronics Industry.

The LPL system is the first new AI language compiler system—integrating logical-type and functional-type elements—that has been independently developed in China. The complete system is made up of a compiler subsystem and a fun subsystem, and its chief characteristics are:

1. The LPL system can compile and run the unmodified standard Prolog language, and it is satisfactorily efficient. Users may define and use functions, which overcomes a weakpoint of the Prolog language regarding its expression of algorithms and knowledge.

2. At the same time as the system uses a depth-first search method as a strategy to conserve searches, it can internalize predicates to constitute a heuristic search algorithm for convenient selection by the user, which greatly improves throughput; the system uses a virtual memory technique to overcome the limitations of the rather small amount of RAM available to the system in a microcomputer.

3. The system has fully incorporated Chinese characters, aiding convenience of use.

4. This system is a pure compiler system, and IBM PC macro assembly language is used for the object code, execution speed for which approaches that for Turbo Prolog.

5. The system has a powerful error-checking function that can accurately indicate erroneous values and error locations. After the evaluation, the experts felt that system functions are complete, the design is innovative, the technical specifications are advanced, that it can be easily ported to other machines, and that it has a high usage value; the system is the first logical language to incorporate heuristic search algorithms and use virtual storage techniques, an area in which it is at the forefront domestically. Testing proved that its primary specifications all meet advanced standards for similar international systems of the mid- and late 1980s.

New C Language Tools Announced

90CF0130E Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 41, 25 Oct 89 p 18

[Article by Wang Zhengsan [3769 2973 0005]: "PECL—A C-Language Programming, Analysis, and Debugging Tool"]

[Text] PECL, recently developed by the Shanghai Computing Institute, is a small, comprehensive C-language software development environment. It strives to reduce the demand on the user for knowledge of the language and syntax analysis. Its primary features are:

—It combines structured programming techniques with text-editing techniques, and flexibility is provided by allowing the user to switch levels at any time.

—Two equivalent syntaxes (i.e., describing the same language) are used for syntax analysis of template derivation for structured programming and for input symbol flows, which enhance the user visibility of the template derivation process.

—It uses screen display techniques to reduce the burden on the user regarding syntax trees. PECL uses such means as color, the cursor, and reverse video to outline the scope of the current node, which also gives rules to levels of retrieval of the syntax trees.

—It provides various flexible means of modification. PECL has taken over different effective means of modification from current text editing, full-screen editing, and structured editing, and has combined these things into one, which makes it very convenient and flexible for the user to modify his source program.

—It generates C source program files that are completely compatible with other editing tools, so the user may also be using other editing tools apart from PECL.

—It has a dynamic data-flow analysis function, which is integrated with structured programming functions to greatly enhance its usability.

Hardware required to support PECL is an IBM PC XT or compatible, with 512K-bytes of RAM. The operating system should be PC-DOS 3.0 or other compatible version. This achievement is now in practical testing.

16-Bit Single-Board Simulation System

90CF0130F Beijing JISUANJI SHIJIE [CHINA COMPUTERWORLD] in Chinese No 41, 25 Oct 89 p 20

[Article by Zhang Lie [1728 3525]: "New MCS-96 16-Bit Single-Board Computer Software Simulation Development System"]

[Text] Because of their high level of integration, small size, and powerful functions, single-board computers are widely used in such fields as industrial control, intelligent instrumentation and meters, and robots. Following upon its MCS-48 and MCS-51 series, the Intel company also brought out the MCS-96 series of 16-bit single-board computers in 1983, which went into use in 1985. The MCS-96 series is a single-board computer having the highest level of integration and most powerful functions in the world today. Some people predict that the 1990s will be the era of the 16-bit single-board computer, which will have a strong position in industrial control, intelligent instrumentation and meters, aeronautics and astronautics, and in defense industries. Development and application of 16-bit single-board computers is quite widespread in developed nations at present. But because the MCS-96 single-board computer is rather expensive and lacks development tools, it has been hard for most scientific researchers to come into contact with it and to become familiar with it. With this in mind, the Xi'an Asia-American S&T Service Bureau has recently developed an MCS-96 software simulation development system. This system is on only two floppy disks, and one can freely develop and simulate running MCS-96 programs on an IBM PC and compatibles. It may be regarded as an economic, practical, and convenient means for learning, mastering, developing, and applying the MCS-96 single-board computer. Naturally, for users having real-time development configurations, this is an even more powerful means of assistance.

The MCS-96 software simulation development system sets up a simulation environment on an IBM PC for the MCS-96 single-board computer, it uses software to simulate hardware, and it therefore accomplishes "the softening of hardware."

This system provides the following functions:

1. A cross-assembler function. Its speed is four or five times that of ordinary high-level languages, it has 11 pseudo commands, and it is easy to use.

2. Error and debugging functions. There are 30 commands. One can run in such modes as real-time, single-step, break-point, and tracing on the target program (that break-point mode includes address break-points, interval breakpoints, and register value breakpoints); one can assemble and disassemble instruction by instruction; through the window display mode, one can show the status of such values as each step of assembled code, each internal register (including FIFO and CAM), I/O ports, stacks, and the program pointer; one may modify and display the contents of registers and any address; and one may record and display the execution path and internal status of the program, allowing the user to understand at a glance the execution process of the program, by which it is quite easy to find and modify errors in programs.

3. Even-odd address partition function. One may place debugged target routines in even-odd address partitions for better transfer.

4. On-line transmission function. Debugged target routines can be transferred via the PC RS-232 serial port to MSC-51 or other development devices for burning into EPROMs.

Bomber Simulation Via S-B Computer

90CF0130G Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 26 Oct 89 p 2

[Article by Chai Ying [2693 5391]: "Single-Board Simulated Bomber Computer System Successfully Developed"]

[Text] A bomber simulation computer system using single-board computer technology has been developed; having undergone 2 years of development by Institute No. 3 of the Air Force, the system recently passed its technical evaluation. The experts felt that the system is of an advanced domestic level.

The simulated bombing is non-bomb-release bombing practice on real targets by attack and bomb air units. Bombing accuracy is determined as the computer system calculates flight parameters and solves equations for the aerial bomb path.

This system marks the first time a domestic command flight bombing trainer has used advanced single-board technology and AC-DC transformer technology, and various methods were used in the software design to improve the accuracy of calculations. These features have kept the size and weight down, and the structure simple. It can conveniently interconnect with radar, which greatly improves system reliability; this has resolved a technical difficulty whereby it has been difficult to improve simulation of bombing accuracy. After more than 500 test flights, no problem has developed in the system, as it has attained and exceeded the original technical requirements. This will not only improve the recognition abilities of pilots regarding real targets, but will greatly conserve ammunition and target range maintenance costs. Units so equipped will be able to save about 1 million yuan annually, which will have important significance for improving unit training results and actual combat capabilities, and for guaranteeing safety.

Six Millimeter-Wave-Technology Breakthrough Achievements Accredited

40080009F Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 5 Jan 90 p 1

[Article by Tang Jingshun [0781 2529 7311]]

[Summary] Six new 3-millimeter-wave-technology achievements of Southeast University's Microwave Laboratory recently passed technical appraisal, thus breaking the embargo placed upon China by certain foreign countries with respect to this technology. Millimeter-wave devices are employed in several high-tech fields such as communications, radar, remote sensing, guidance, and medical treatment. The six new achievements, funded by the National Natural Science Foundation, include a state-of-the-art 3-mm-band hybrid integrated subharmonic mixer using domestically made 4-6-mm coaxial package mixer tubes with a low local-oscillation frequency; this device will further the development of front-end circuits for low-noise integrated receivers. The 3-mm-band high-end single-cavity dual-element harmonic-power synthesizer will aid domestic research and development of several kinds of 3mm-band systems by providing a relatively high-power signal source. Also certified were a 3-mm-band finline PIN diode switch, a 3-mm-band finline directional coupler, a millimeter-wave digital attenuation tester, and a transmission-line-discontinuity electronic software package.

National Laboratory for Sensor Technology Certified

40080009E Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 31 Dec 89 p 2

[Article by Bao Jiannong [7637 1696 6593]]

[Summary] The joint open Key State Laboratory for Sensor Technology passed its acceptance check, sponsored by the State Planning Commission and the Chinese Academy of Sciences (CAS), a few days ago in Shanghai. The laboratory has been formed from elements of the CAS Shanghai Institute of Metallurgy, the CAS Institute of Semiconductors, and nine other research units, and will be under the direction of Researcher Wang Weiyuan [3769 3262 3293] from the CAS Institute of Metallurgy. Since its establishment in 1987, the laboratory has been equipped with tunable laser systems, and advanced instruments for technologies such as reactive ion etching [RIE], low-pressure chemical vapor deposition [LPCVD], and semiconductor parametric determination. The laboratory, which has been involved in "863 Plan" projects over the past 2 years, has developed several basic bioengineering sensors—such as a high-temperature PH electrode, a glucose sensor, a defoaming sensor, and a penicillin-sensitive field-effect sensor—that meet advanced international standards. The laboratory has already batch-produced platinum thin-film thermometric elements and platinum resistance elements, and its mercury-cadmium-tellurium infrared sensor was successfully employed in the "Fengyun-1," China's first weather satellite.

Large-Scale Laser Holographic System Developed

90CF0181a Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 29 Oct 89 p 1

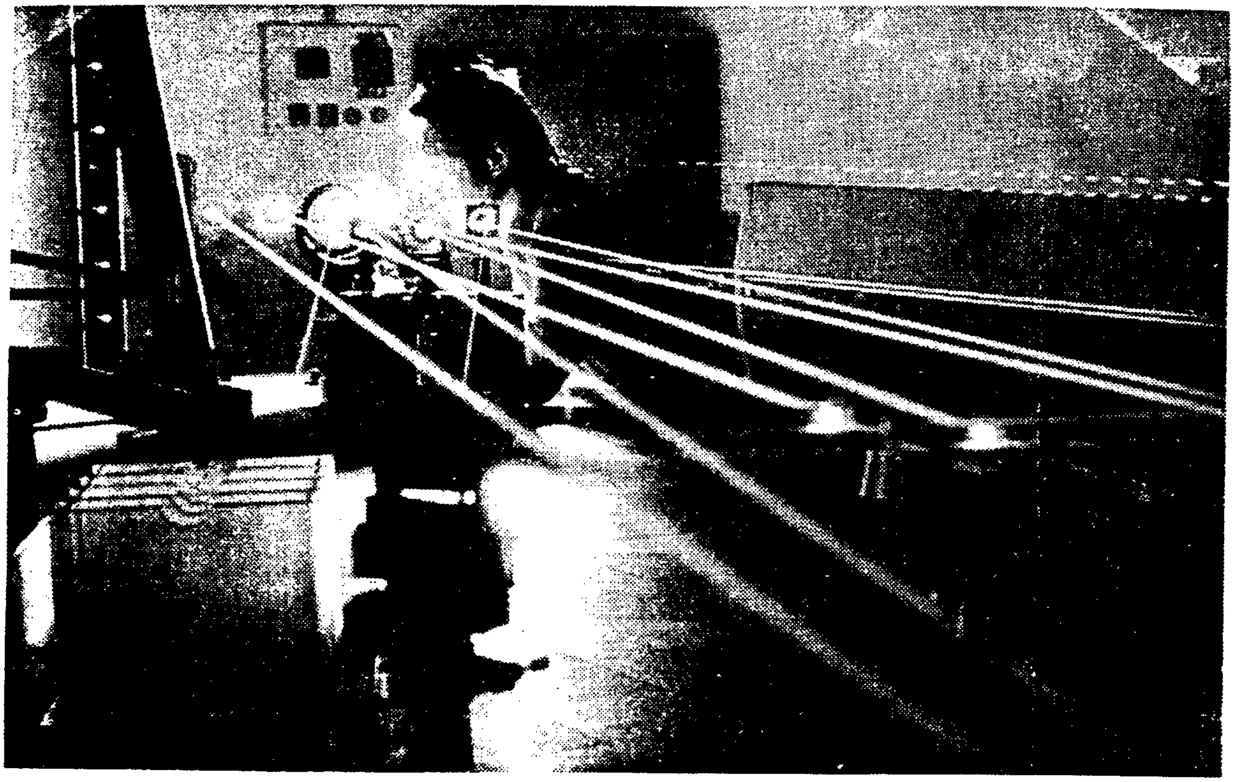
[Article by correspondent Shi Xu [2514 2485] and reporter Liu Dong [0491 2767]: "Successful Development of Large-Scale Laser Holographic System"]

[Text] In addition to assembly and testing of various satellites and development of certain equipment, Plant 529 of the Ministry of Aeronautics & Astronautics Industry has also developed a piece of large- scale equipment—a He-Ne laser holographic system.

The nonmetallic testing laboratory of Plant 529 first proposed to build a full-view non-contact laser holographic system for non-destructive testing in 1986. With the support of the plant's leadership, technical members such as Tian Guangyi [3944 0342 5030], Li Fengchun [7812 6646 2504], Na Hongyue [6719 7703 1878] and Liu Zhangjie [0491 2069 2212] overcame one technical hurdle after another and finally completed the assignment in September [1989].

The system has high sensitivity and good reproducibility and collects reliable data. It has a bright future in a wide range of applications. The certification committee believed that the equipment and the product testing technique associated with the system has reached an advanced level similar to that of other comparable systems built in the 1980's.

Photograph shows a technician fine-tuning the laser.



Feature on Prominent Radar Specialist

90CF0181b Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 10 Nov 89 p 2

[Article by Cai Shanwu [5591 0810 2976]: "Chief Radar Engineer—Li Nengjing [6786 5174 2417]"]

[Text] Li Nengjing, the prominent radar expert, has left a string of records in his 60 years of life.

In 1951, the American Imperialists invaded Korea and war was brought to the front door of our country. Li joined the Chinese People's Liberation Army after he graduated from Shanghai Jiaotong University. Since then, he has been engaged in the research and development of radar equipment for nearly 40 years.

In the early 1950's, radar equipment and technology was a "cutting-edge" science in China. Li and several other comrades went on naval vessels to inspect and repair the American-made warning-radar systems left behind by Chiang's Navy. After working day and night for five months, all ten radar systems were repaired and put to use in the field. Later, Li led a group of people developing an identification friend or foe [IFF] system. In addition, he represented the armed forces in dealing with China's first radar manufacturing plants and research institutes in the demonstration of feasibility and production of the first air- intelligence radar and surface-vessel warning radar ever designed in China. These radar systems, later produced in large quantity and issued to troops, became a major force in air and coast defense.

Li has been involved and in charge of the development and proof of feasibility of air-intelligence radar systems over a long period of time. In the past three decades, he devoted himself to almost 20 different radar systems. They include a warning radar which is widely used by the Chinese armed forces, a low-altitude moving-target-indicator [MTI] radar which was independently developed in spite of foreign embargo, and a three-coordinate radar which reflects the level of our modernized equipment. In the development and production of these radar systems, he participated in tactical requirement discussion, formulated overall plans and organized technical certification. The remote-control device for mountain radar stations is the first such device in China. It solved the problem of troops deployed at mountain radar stations. He is known as the "chief radar expert" in the radar field.

In the early 1970's, he read about the advent of digital radar technology in foreign technical journals. He then organized some people and became the first one to study digital MTI technology in China. In conjunction with several other institutions, his group developed China's first digital MTI equipment, which filled a void in China's radar technology. In the 1980's, he has been active in organizing research on new radar systems in order to develop a new generation of radars in the future.

Li's technical achievements are widely recognized in the world. He has published over 20 technical papers in journals and conferences throughout the world and has been invited to international radar meetings.

In October 1987, based on his 40 years of experience, Li wrote a paper entitled "Cost-Effective Analysis of Air-Defense Search Radar" and presented it at the Sixth International Radar Conference in London. Prominent radar experts praised his paper, which discussed the direction of search radar development from a broad perspective and provided a new way to evaluate a search radar. This is not only praise to Li but also an indication that China's radar technology has reached world-class.

In order to recognize Li's contribution, the National Science Conference awarded him a certificate as an advanced technical worker and the Air Force Party Committee gave him the title of outstanding intellectual.

Domestic Fiber-Optic Industry Profiled

Communications Near World Standard

40100030 Beijing CHINA DAILY (Business Weekly) in English 19 Feb 90 p 4

[Article by journalist Chen Jingsong, specialist on the electronics industry, and staff reporter Huang Xiang; first paragraph is CHINA DAILY introduction]

[Text] The optical fibre industry has developed rapidly in China following 20 years of painstaking effort by scientists and engineers. Journalist Chen Jingsong, a specialist on the electronics industry, and our staff reporter Huang Xiang interviewed engineers and research workers on the progress and prospects of the industry.

Experts are saying the optical fibre industry is China's highest high technology.

With optical fibre China will approach international standards in communications in less than 10 years.

This is due to the efforts of 120 research institutions and manufacturers.

Scientists here have mastered the basic, super, master, supermaster, and jumbo group optical fibre communication systems.

These have been widely applied in communications, radio and television, military affairs, computer networks and transportation administration.

To date, 11,000 kilometres of optical fibre lines are in use.

In 40 cities, inter-city telephones are connected by fibre optic cables and 8 provinces have built long-distance optical fibre communications lines. A 5-kilometre underwater fibre optic cable, composed of 10 hair-like colourless optical fibres, has been developed by the Shanghai Cable Plant to run 30 metres deep in the Yangtze River at the section near Wuhu in Anhui Province to support telecommunications between Wuhu and Hefei, capital of the province.

Trunk Line

A trans-China optical fibre telecommunication trunk line is expected to be completed by the year 1990, connecting Nanjing in Jiangsu Province in the east, to Wuhan in Hubei Province and Chongqing in Sichuan Province to the west. The 2,200-kilometre line will be Asia's longest fibre optic cable trunk line.

Another trunk line north-south is underway. It will connect Harbin, Beijing, Yantai, Qingdao, Lianyungang, Shanghai, Ningbo, Fuzhou and Guangzhou.

Meanwhile a localized integrated digital communication network (IDCN) has been established in Beijing with programme-controlled exchanges and a master group fibre optic cable telephone repeater system.

Network

Beijing has China's largest inter-city telephone network, which comprises 100,000 lines of telephones, 4,570 lines of junction equipment, 2,000 lines of domestic long-distance telephones and a series of ancillary equipment.

Tianjin, Shanghai and Guangzhou are also using the technology to renovate inter-city telephone systems of their own.

Optic fibres have linked Guangzhou with Hong Kong and are going to be extended to 10 other cities in southern China.

To date, 240 optical fibre systems have been installed in China, including 200 private systems and 40 public ones. The 15 model optical fibre communication systems, designed on an experimental basis, have been completed.

Big strides have been made in the research and manufacture of material.

The master group system optic terminal and the optic repeater developed by the Chongqing Communications Equipment Plant have met the requirements of the Consultation Committee of International Telex and Telephone (CCITT).

Major technical indices of the multimode and cable connector developed by the No. 23 Institute under the Ministry of Machinery and Electronics Industries have met mid-1980s standards. The Ministry's No. 44 Institute has just developed the monomode optical fibre compact with major technical indices meeting international standards of the 1980s. A monomode fibre optic connector and the monomode fibre optic coupler developed by the Shanghai Transmission Cable Institute conform to International Electrotechnische Commission (IEC) standards.

Devices

At present, China has at least 50 kinds of optic-electric devices in mass production.

Annual output of optic cable amounts to 160,000 kilometres, and is expected to double by the year 2000.

Compared with coaxial cable, fibre optic cable is smaller, easier to install, capable of higher frequencies and has larger capacity. Global optical fibre communications has developed rapidly and experts predict that the next century will be an era of "optical fibre communications." To attain international standards in this technology, researchers and technologists in China are devoting themselves to the development and manufacture of new optical fibre communications equipment.

Plan, Oversight, Funds Needed

40100030 Beijing CHINA DAILY (Business Weekly) in English 19 Feb 90 p 4

[Article by jounalist Chen Jingsong, specialist on the electronics industry, and staff reporter Huang Xiang; first paragraph is CHINA DAILY introduction]

[Text] The optical fibre industry has developed rapidly in China following 20 years of painstaking effort by scientists and engineers. Journalist Chen Jingsong, a specialist on the electronics industry, and our staff reporter Huang Xiang interviewed engineers and research workers on the progress and prospects of the industry.

Experts are saying that while China's optical fibre industry represents the country's greatest hi-tech achievement, further measures should be taken promptly to keep it growing.

The industry needs more general planning work, Business Weekly learned in extensive interviews, more efficiency from manufacturers, and the continuous use of foreign capital and imports while establishing development funds for domestic firms.

At a meeting last October in Suzhou, experts claimed that optical fibre manufacturers in China are far from efficient.

Currently the 15 Chinese factories produce less than 10,000 kilometres of optical line very year. But by standards in developed countries, 10 times more should have been made, said Wei Shilin, an official with the Ministry of Post and Telecommunications.

China imported 29 smelting machines but they are scattered around a dozen cities owned by separate factories. This greatly reduces efficiency.

Experts suggested at the meeting that government should emphasize efficiency rather than number of factories producing optical fibre.

They suggested that the whole industry needs an authoritative department in charge of general planning.

At present, the State Science Commission deals with research while application is run by the Ministry of Post and Telecommunications, the major user of the fibres and cables. But a majority of the manufacturers of optical fibres and cables belong to the Ministry of Machinery and Electronics. The State Council does have an Office of Promotion and Application of Electronics and Information Systems. But it oversees so much of the country's communications work that it is not geared to guiding any particular industry.

"As a result, each department tends to its own interests which hinders the industry as a whole," said Wu Quanyuan, an official with the State Council office.

In view of increasing overseas loans to the industry, experts said that development should focus first on foreign-funded or partially foreign-funded factories. They said this would alleviate the funds shortages resulting from the austerity programme.

"These firms usually make better and more sophisticated products than Chinese factories," said Wu.

In the past decade the industry has drawn capital from Japan, West Germany, France, and the Netherlands.

Further, the experts recommended that the central government impose higher tariffs on imports to protect joint ventures or Chinese firms producing optical fibre technology.

Wu said that a 12-per cent import tariff is imposed on these goods by China while in France the figure is 100 to 200 per cent and in South Korea it is 100 per cent.

"The Japanese government has also been adopting a preferential policy to encourage the purchase of domestic products," he said.

In view of the growing domestic demand, experts asked for the pooling of funds from all departments concerned including local departments.

For a small industry to cope with a big market, "a hi-tech industry has got to have special funds," Wu said.

The specially designated fund would be used to improve large and mid-sized manufacturers, establish model projects, and support research.

They said this pooling is especially important when the central government is not increasing investments in the communications industry.

Optical Fiber Modernizes Communications

40100030 Beijing CHINA DAILY (Business Weekly) in English 19 Feb 90 p 4

[Article by journalist Chen Jingsong, specialist on the electronics industry, and staff reporter Huang Xiang; first paragraph is CHINA DAILY introduction]

[Text] The optical fibre industry has developed rapidly in China following 20 years of painstaking effort by scientists and engineers. Journalist Chen Jingsong, a specialist on the electronics industry, and our staff reporter Huang Xiang interviewed engineers and research workers on the progress and prospects of the industry.

Optical fibre has it all over metal in making communications cable.

The technology, developed in China in the mid-1970s, is used in a dozen provinces and cities. Eleven thousand kilometres of optical cable have already or are being installed, according to sources.

They say that the 15 model projects, designated by the State Council to experiment with the new technology, are doing the job.

These projects include public telephone systems, broadcasting and television services, railway and power line communications, and surveillance systems used in industrial enterprises and by police and the military.

Last July, 250 kilometres of optical lines linked Hanyang and Jingzhou in Hubei Province, the longest domestic-made optical communications line in use. An imported 2,400-kilometre optical transmission system is expected to be installed between Nanjing, capital of Jiangsu Province, and Chongqing by the end of 1990. The two cities are 1,000 kilometres apart.

Sources from the Ministry of Posts and Telecommunications also said that the work on the two joint ventures under construction in Xi'an and Wuhan, are proceeding as scheduled. The Ministry expects production of 100,000 kilometres of the fibre next year. Ten domestic firms in China are producing 1,250 kilometres of optical fibres a year. Experts say this output is unsatisfactory, in terms of quantity, quality, and cost.

The Ministry, as the major promoter and user of the technology, has made fibre lines the major transmitter of future long distance and local telephone networks.

"We'll continue to apply the cables to the country's trunk lines during the Eighth Five-year Plan period (1991-1995). Local governments are responsible for obtaining funds for the local installation work," said Wei Shilin, an expert with the Ministry's Optical Fibre Communications Office, which is responsible for research in the field.

He said while China will focus on developing its own optical fibre industry the Ministry will continue to work with foreign partners during the period.

Wei said that optical fibres, which allow thousands more simultaneous conversations than the more expensive copper cables, will ultimately replace all metal lines. The fibre lines are also free from electromagnetic interference and easy to install.

The Ministry is considering drafting an outline to guide development together with the Ministry of Machinery and Electronics, which oversees many optical fibre manufacturers.

Major Satellite Earth Station Operational

40080009C Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 12 Dec 89 p 1

[Article by Huang Jiwei [7806 4949 0251]: "Commission of Science, Technology & Industry for National Defense's Central Satellite Earth Station Made Available to Users"]

[Summary] The Commission of Science, Technology & Industry for National Defense's Central Satellite Earth Station, developed jointly by Institute 54 of the Ministry of Machine-Building & Electronics Industry and other units, has now been handed over in Beijing for use. This station, which is the main hub of the Commission's satellite communications network, has a 15-m antenna for transmission of encrypted speech, data, television, and other information; it will provide command, monitoring, dispatch, and management functions to all stations in the network. In the preparatory phase, engineers overcame many obstacles and successfully linked the station up with the international [telecommunications] network. The station has passed tests to certify it to be above the [minimal] qualifications for the International B Standard earth station.

Outlay for Rural Satellite Ground Stations in Yunnan Reported

40080009D Beijing ZHONGGUO DIANZI BAO [CHINA ELECTRONICS NEWS] in Chinese 15 Dec 89 p 1

[Article by Zhou Shiding [0719 4258 0089]]

[Summary] The Yunnan Province Broadcast Television Department, the Yunnan Province Nationalities Affairs Commission, and the Yunnan Province Finance Department recently jointly outlaid 600,000 yuan for the construction of 20 satellite ground receiving stations in border towns populated by minority groups. Towns receiving ground stations include Zhaotong, Chuxiong, Honghe, Simao, Dali, Baoshan, Dehong, Lijiang, and Deqen, as well as [the provincial capital] Kunming. Some of the 3.2-m tabular-antenna satellite TV receivers, manufactured by the Yunnan Province Electronics Industry Research Institute, are already in use.

Fiber-Optic Line in Guangdong Province Expanded

40080009B Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese No 1, Jan 90 p 45

[Unattributed article]

[Text] The Guangzhou-to-Foshan fiber-optic communications project, originally begun with equipment imported from England, uses 12-fiber cable (in six systems). The first phase of the project, operational at the end of 1985, included two 140Mbps [DS4] terminal equipment systems which carried 480 circuits. In 1988, with the installation of equipment made by the Ministry of Posts and Telecommunications' Guangzhou Communications Equipment Plant, capacity was expanded by 960 circuits. Last year [1989], more domestically made equipment was put into use, adding 2,400 circuits. The completion of this expansion project has greatly relieved the overburdened circuit situation in the Zhujiang Delta and parts directly westward in Guangdong Province.

New Fiber-Optic Line for Shanxi Province Completed

40080009A Beijing DIANXIN JISHU [TELECOMMUNICATIONS TECHNOLOGY] in Chinese No 12, Dec 89 p 47

[Article by Li Jing [6849 0664]]

[Text] A fiber-optic cable project linking the six Taiyuan municipal telephone branch offices with Jinci has been completed; cable length is 20 km and total investment is 1.25 million yuan. Utilized in the project are the Xigu [6007 0657] Company's 10-fiber skeletal-type single-mode copperless-core optical cable, DS2 [8Mbps, 120 voice circuits] optical terminals made by Wuhan Institute of Posts and Telecommunications, and digital equipment from Chongqing Communications Equipment Plant; the 4BIH coding method is employed. Of the total 20 km, 12 km of cable will be in conduit and 8 km will be strung in overhead line(s). Ninety circuits are already operational.

Nation's First Synchrotron Radiation Facility Now Operational

90CF0193a Shanghai ZIRAN ZAZHI [NATURE JOURNAL] in Chinese Vol 12 No 11, Nov 89 pp 815-817

[Article by Xi Dingchang [0405 7844 2490] and Tang Esheng [0781 6759 3932] of the Institute of High-Energy Physics, Chinese Academy of Sciences]

[Excerpts] On the evening of 3 April 1989, the blue light indicating forbidding of electron-positron injection into the storage ring went off and the yellow light permitting entry came on outside the main experiment hall of the Institute of High-Energy Physics of the Chinese Academy of Sciences (CAS). Scientists and engineers went inside the main hall. After several control knobs were pressed down, the two beam lines in the hall produced bright white light. Those present cheered and applauded in celebration of a great moment in China's science history. In that evening, China had its first synchrotron radiation light source. [Passage omitted]

Different investigations require different wavelengths; but on the whole the wavelength must be comparable to the size of the objects under study. In the study of microbiology with a size scale of 0.1 μm, visible light with a wavelength of about 0.5 μm serves as a suitable light source. In the study of material structures, however, the size scale is quite different. For example, atoms are typically 3 Angstroms in size (an Angstrom is 1/10,000 micron) but the size of a protein crystal can be as large as several tens of thousand Angstroms. To span such a wide size variation, it would be most desirable to have a variable-wavelength light source. Modern technology also requires a more intense source; for example, in the measurement of large molecular crystals with conventional X-ray diffraction, the weak intensity and the large number of diffraction points make the data collection time as long as several tens of days for one set of diffraction measurements. To collect enough data to determine the crystalline structure, it would take years.

Synchrotron radiation light sources built at various places in the world would satisfy the wavelength and intensity requirements of modern technology. In the mid 1940's, physicists predicted theoretically that electrons moving in a nonlinear path at a speed close to that of light would emit a very strong electromagnetic radiation (see Figure 1). In 1947, such radiation was first discovered with an electron synchrotron accelerator at the General Electric Company in the United States; it was hence called "synchrotron radiation."

In the beginning, synchrotron radiation was viewed as an unwelcome obstacle in achieving higher particle energy in the accelerator. Unexpectedly, after 20 years, synchrotron radiation has become highly popular because of its desirable properties.

The [Beijing] electron-positron collider built at the Institute of High- Energy Physics, CAS, is a device for

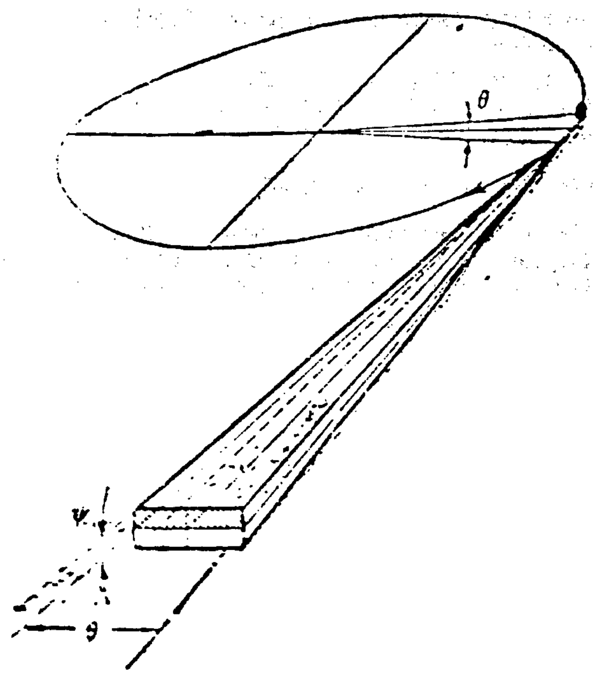


Figure 1. Electrons Revolving Close to the Speed of Light Emit Strong Synchrotron Radiation

conducting high-energy physics research and also a source for synchrotron radiation. The electrons and positrons are injected into the storage ring through a 200-m-long linear accelerator. Electrons revolve in the storage ring in the clockwise direction and positrons revolve in the counter-clockwise direction. They collide at two points. At one collision point, scientists built complex detectors for high-energy physics studies. As electrons and positrons revolve in the storage ring, they constantly emit synchrotron radiation. Three "windows" were built to bring out the synchrotron radiation into five beam paths and finally into the experiment stations.

The wavelength of the synchrotron radiation generated at the Beijing electron-positron collider is continuous and coves a wide range from infrared to X-ray (see Figure 2). Generally speaking, the higher the electron energy, the higher the percentage of short X-rays in the synchrotron radiation spectrum. Scientists introduced a quantity called "characteristic wavelength" that occurs approximately at the maximum of the spectrum. The characteristic wavelength of the Beijing electron-positron collider is 5.5 Angstroms when the collider is operated at a 2.2-GeV energy level (this energy is equivalent to a temperature of 25 trillion degrees). Hence, the usable wavelength [range] includes 1.5- Angstrom X-rays to wavelengths longer than that of visible light. In order to select suitable wavelengths for experiments, five beams have been built for different purposes.

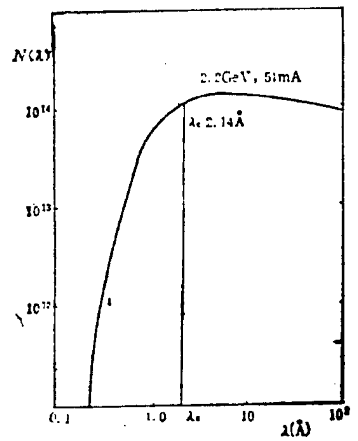


Figure 2. Synchrotron Radiation Spectrum of the Beijing Electron-Positron Collider at 2.2 GeV. (:glc is the characteristic wavelength)

If even shorter wavelengths are desired (as is often the case in the study of materials structure and large biological molecules), a special device is needed. Scientists and engineers installed equipment called "torsion-pendulum magnet device" to vibrate the electrons rapidly as they pass through the magnetic field and thereby obtain X-rays of even shorter wavelengths (Figure 3).

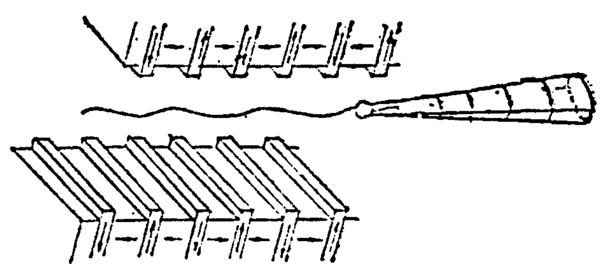


Figure 3. Shorter Wavelength Synchrotron Radiation Was Obtained by Undulating the Electrons

On the morning of 4 April, scientists and engineers installed the torsion-pendulum magnets. When the magnetic field was increased to several thousand Gauss, a light spot due to the undulating electrons appeared next to the original synchrotron radiation. Figure 4 [not reproduced] shows the visible portion of the synchrotron radiation. Figure 5 [not reproduced] shows the fluorescence of the screen when it was bombarded by the X-ray component of the synchrotron radiation.

The above preliminary photos showed some characteristics of the synchrotron radiation. One property is its high intensity; one thousand to one million times stronger than conventional X-ray intensity. Another property is its high degree of alignment; the X-ray partial perpendicular emission angle of the synchrotron radiation is only a few tens of a milliradian. These photos do not show the polarization property of the synchrotron radiation. Synchrotron radiation is highly polarized; radiation emitted in the plane of the electron motion is 100percent linearly polarized light.

Another important property of the radiation is its temporal structure. Since the electrons revolving in the storage ring do so in the form of packets, the emitted synchrotron radiation is pulsed. When the electrons move in the form of a single packet in the Beijing electron- positron collider, the pulse separation is 0.8 μs and the pulse width is 80-300 ps, depending on the average electron current. Figure 6 [not reproduced] shows the pulse structure of the radiation as observed on a picosecond-level streak camera. The conditions at the time were 2.2 GeV for the electron energy, 15 mA for the average current, and 250 ps for the pulse width. As to the continuous wavelength nature of the radiation, it has already been discussed in detail in the beginning.

Five beams have been built in the Synchrotron Radiation Laboratory at the Institute of High-Energy Physics, CAS. One X-ray beam is used for investigating crystalline morphology, two other X-ray beams are used in the study of materials and biological crystalline structures using absorption, diffraction, and scattering methods. A soft X-ray and vacuum ultraviolet beam is used for surface science studies and another soft X-ray beam is used for developing photoetching technology in microelectronics. The wavelength and spot size of the beams are selected using the mirrors in the beamline and using wavelength- selecting monochromators. Figure 7 [not reproduced] shows several beamlines under adjustment at the synchrotron radiation facility.

The successful operation of the Beijing electron-positron collider synchrotron radiation marked the beginning of a new era in China's history of science and technology. It can be expected that the synchrotron light source and the associated beamlines and experiment stations will be a powerful tool in China's scientific research and technological development.

Study of Surface Properties of $Al_xGa_{1-x}As(100)$

40090005a Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 38 No 12, Dec 89 pp 1968-1973

[English abstract of article by Huang Chunhui [7806 2504 2547], Lu Xuekun [4151 1331 0981] et al., of the Surface Physics Laboratory, Fudan University, Shanghai]

[Text] The surface states of $Al_{0.7}Ga_{0.3}As(100)$ were studied by ultraviolet photoelectron spectroscopy. It was found that two surface states exist on the $Al_{0.7}Ga_{0.3}As(100)$ surface, which can be removed by the adsorption of 1500 L hydrogen. The evolution of these two surface states with thermal annealing has been investigated. Combining these findings with the experimental results of LEED [low-energy electron diffraction] and XPS [X-ray photoelectron spectroscopy], it is recognized that the surface damage can be removed effectively

by thermal annealing at a temperature near 450°C, and a nearly perfect surface of $Al_{0.7}Ga_{0.3}As(100)$ can be obtained.

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